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Presence and Distribution of Amphibians in the Williston and Dinosaur Reservoir Watersheds

P. E. Hengeveld
February 2000

PWFWCP Report No. 212

The Peace/Williston Fish & Wildlife Compensation Program is a cooperative venture of BC Hydro and the provincial fish and wildlife management agencies, supported by funding from BC Hydro. The Program was established to enhance and protect fish and wildlife resources affected by the construction of the W.A.C. Bennett and Peace Canyon dams on the Peace River, and the subsequent creation of the Williston and Dinosaur Reservoirs.

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Abstract

The Peace/Williston Fish and Wildlife Compensation Program conducted reconnaissance amphibian surveys in the spring of 1998 and 1999 to document amphibian presence throughout the Williston and Dinosaur Reservoir watersheds. Breeding call and aquatic surveys were conducted at selected sites in a variety of biogeoclimatic subzones. In 1999, Backyard Amphibian and Reptile Survey volunteers monitored spring and summer amphibian activity at two sites in and adjacent to the Williston Reservoir watershed. Data from the 1998 and 1999 PWFWCP amphibian surveys and the 1999 Backyard Surveys, and unpublished data collected from 1995 to 1997 by Slocan Group, Mackenzie Operations, were compiled to provide a summary of amphibian presence and distribution within the Williston and Dinosaur Reservoir watersheds. As expected, western toads *(Bufo boreas)*, wood frogs *(Rana sylvatica)*, and Columbia spotted frogs *(Rana luteiventris)* were found to be widespread throughout the watersheds; they were found in Sub-boreal Spruce (SBS), Boreal White and Black Spruce (BWBS), and Engelmann Spruce Subalpine Fir (ESSF) biogeoclimatic subzones. Striped chorus frogs *(Pseudacris triseriata)* were detected only in the Hudson's Hope area (BWBS mw1). Long-toed salamanders *(Ambystoma macrodactylum)* were detected primarily at low-elevation sites around the Williston Reservoir: SBS mk, SBS wk, and BWBS dk subzones. An extension to the long-toed salamander's northern distribution was identified. Although biogeoclimatic zones and subunits appear to be useful sampling units for determining landscape-level amphibian distribution, the variation in subunit and site variables makes it difficult to use them to derive any conclusions about the apparent absence of a species from an individual survey area or site.

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1.0 Introduction

The Peace/Williston Fish and Wildlife Compensation Program (PWFWCP) initiated reconnaissance amphibian surveys in the Williston and Dinosaur Reservoir watersheds in 1998 (Hengeveld 1999). The objective was to document the presence and distribution of amphibian species suspected to reside in the watersheds: western toads *(Bufo boreas)*, wood frogs *(Rana sylvatica)*, Columbia spotted frogs *(Rana luteiventris)*, striped chorus frogs[1] *(Pseudacris triseriata)*, and long-toed salamanders *(Ambystoma macrodactylum)*. Stratification of the watershed into survey units was based on the Biogeoclimatic Ecosystem Classification (BEC) system. Subdivisions within the BEC system (e.g., subzones, variants) were used to delineate survey units as they integrate climatic, vegetative, and site variables which are thought to be relevant to amphibian presence and distribution, and they also form the basis for resource management decisions in British Columbia (BC).

In May 1998, surveys conducted in 5 biogeoclimatic units within the Parsnip (southern) and Peace (eastern) regions of the study area confirmed the presence of western toads, wood frogs, spotted frogs, and long-toed salamanders. Although no striped chorus frogs were detected, they were expected to be present in the Peace region, east of the Rocky Mountains (Nussbaum et al. 1983, Green and Campbell 1984, Corkran and Thoms 1996).

Based on the 1998 survey results, additional amphibian surveys were scheduled for the spring of 1999. The objectives of the 1999 surveys were to:

- confirm the presence of striped chorus frogs in the Peace region.
- conduct surveys for all amphibian species in biogeoclimatic units and geographic regions not previously surveyed, including sites in higher elevation biogeoclimatic zones [i.e., Engelmann Spruce-Subalpine Fir (ESSF), Spruce-Willow-Birch (SWB), and Alpine Tundra (AT)], and sites in the Finlay (northern) region.

[1] Also known as boreal chorus frogs, *Pseudacris maculata*.

In 1999, the PWFWCP also initiated a 'Backyard Amphibian and Reptile Surveys' program in the watershed. The program was modeled on other voluntary amphibian monitoring programs, and invites local residents with an interest in amphibians and reptiles to periodically survey a site (or sites) near their home and submit records of any herptile activity observed. Repeated surveys throughout the spring and summer provide supplementary distribution data and insight to the developmental phenology of local herptiles. Such survey programs provide an effective means of gathering cursory population data for multiple amphibian species, and provide an opportunity for public involvement in wildlife activities.

Information gathered from the 1999 PWFWCP reconnaissance surveys and the Backyard Survey reports will help to identify potential enhancement opportunities and aid in assessing the need for conducting more intensive amphibian inventories, habitat-use surveys and/or longer-term population monitoring programs within the Williston and Dinosaur Reservoir watersheds. The presence and distribution data will also contribute to provincial inventory databases for vertebrates (e.g., Species Inventory database (SPI), Conservation Data Centre, Royal BC Museum), and the new edition of 'Amphibians and Reptiles of British Columbia' (Matsuda et al., in prep).

This report documents the 1999 PWFWCP survey findings and also provides a summary of amphibian presence and distribution data collected to date in the Williston and Dinosaur Reservoir watersheds. Data for the summary was assimilated from the 1998 and 1999 PWFWCP reconnaissance surveys and incidental reports and the 1999 Backyard Surveys program, and unpublished data collected from 1995 to 1997 by Slocan Group, Mackenzie Operations, a forest licencee in the Mackenzie Timber Supply Area (TSA).

2.0 Study Area

2.1 Williston and Dinosaur Reservoir Watersheds

The Williston and Dinosaur Reservoir watersheds, occupying 69,930 km^2 and 750 km^2 respectively (Maclean 1998), are located in north-central BC (Figure 1). The combined area extends from Summit Lake (approximately 30 km north of Prince George) north to the headwaters of the Finlay River and east to the community of Hudson's Hope.

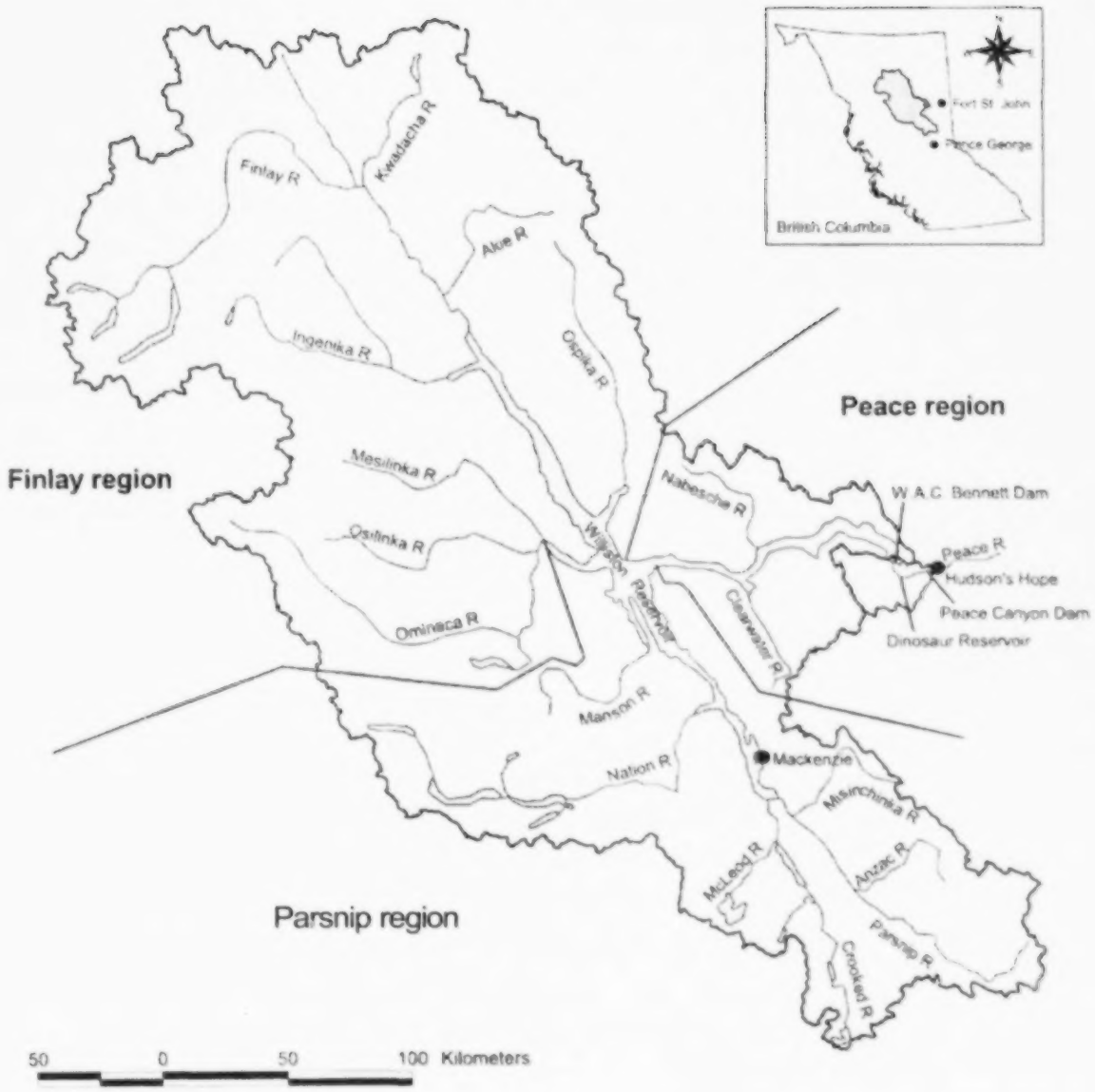

Figure 1. Geographic regions of the Williston and Dinosaur Reservoir watersheds: Parsnip (southern), Peace (eastern), and Finlay (northern).

The Williston Reservoir inundates the valley bottoms of three major river drainages: the lower Finlay and Parsnip Rivers and the upper Peace River. The Dinosaur Reservoir floods a narrow, 23 km long section of the Peace River between the W.A.C. Bennett and Peace Canyon Dams near Hudson's Hope. The southern portion of the Williston Reservoir watershed (Parsnip River drainage) will hereafter be referred to as the Parsnip region, the eastern portion (Peace River drainage, including the Dinosaur Reservoir watershed) as the Peace region, and the northern portion (Finlay River drainage) as the Finlay region (Figure 1).

Physiographically, the Williston Reservoir watershed is dominated by the wide valley of the Rocky Mountain Trench, which is flanked by the Omineca Mountains to the west and the Rocky Mountains to the east. The Omineca and Rocky Mountain ranges influence precipitation levels, resulting in more than 150 cm of annual precipitation on the windward side and less than 50 cm of precipitation on the lee side of these ranges; about 50% of the precipitation occurring in Rocky Mountain Trench and along the reservoir in the Peace region falls as rain, while in mountainous country about 25% of the annual precipitation falls as rain and 75% as snow (Davidson and Dawson 1990). Snow begins falling in October and increases in depth until March or April. The frost free growing period is less than 60 days in most of the Finlay and Parsnip regions, and less than 90 days in the Peace region; the vegetative growing season begins in mid-May in the lower Peace region and about 2 weeks later in the Parsnip and Finlay regions (Davidson and Dawson 1990).

2.2 Biogeoclimatic Ecosystem Classifications

The Biogeoclimatic Ecosystem Classification (BEC) system was developed by the BC Ministry of Forests to provide a framework for resource management and scientific research (Meidinger and Pojar 1991). It is a hierarchical system which integrates primarily climate, soil, and vegetation data. Biogeoclimatic zones (BGZ) are large geographic areas having broadly homogeneous macroclimates and characteristic vegetation communities and soil-forming processes; zones are generally named after one or more of the dominant climax vegetation species in zonal ecosystems. Subzones reflect

differences in regional climate (coded according to relative precipitation and temperature regimes), and variants delineate the geographic location within the zone[2].

There are 5 biogeoclimatic zones in the Williston and Dinosaur Reservoir watersheds: Sub-Boreal Spruce (SBS); Boreal White and Black Spruce (BWBS); Engelmann Spruce - Subalpine Fir (ESSF); Spruce-Willow-Birch (SWB); and Alpine Tundra (AT) (BC Environment 1998; Figure 2).

The SBS zone is predominant in the Parsnip region of the watershed and along the Williston Reservoir's perimeter, occurring from the valley bottoms to 1,100 m elevation (MacKinnon et al. 1990). The SBS landscape is dominated by upland coniferous forests, with wetlands being common. The BWBS zone occupies the main valleys north of the Omineca River, and the lowland/montane areas (up to 1,100 m elevation) in the eastern part of the Peace region (MacKinnon et al. 1990). Lowlands in the BWBS are poorly drained and characterized by a mosaic of forest and wetland ecosystems. Frequent fires (i.e., return interval of 125 to 200 years) and insect infestations are the dominant disturbance in both the SBS and BWBS zones. The ESSF zone occurs above both the SBS and BWBS zones (except for the northern half of the Finlay region), extending from approximately 1,000 m to 1,500 m elevation (DeLong et al. 1994). It occurs primarily in mountainous terrain that is often steep and rugged, with continuous forest at its lower elevations and subalpine parkland at its upper elevations. The SWB replaces the ESSF in the northern Finlay region and is situated at middle elevations (1,050-1,500 m), generally above the lower elevation BWBS zone (MacKinnon et al. 1990). AT occurs above the subalpine zones and is generally above 1,500 m (MacKinnon et al. 1990).

Stratification of the watershed for the purposes of this project was based on the BGZ subunits present, thus there were 16 potential sampling units: SBS mk1, mk2, vk, wk1, and wk2; BWBS dk1, mw1, wk1, wk2; ESSF mc, mv2, mv3, mv4, wk2; SWB mk; and AT (BC Environment 1998; Figure 2).

[2] The first letter of the two letter code for BEC subzones refers to precipitation: x (very dry/xeric); d (dry); m (moist); w (wet); v (very wet). The second letter refers to temperature: h (hot); w (warm); m (mild); k (cool); c (cold); v (very cold). Variants are named by geographic area within a zone, and ordered by increasing number from south to north and from west to east (DeLong et al. 1994).

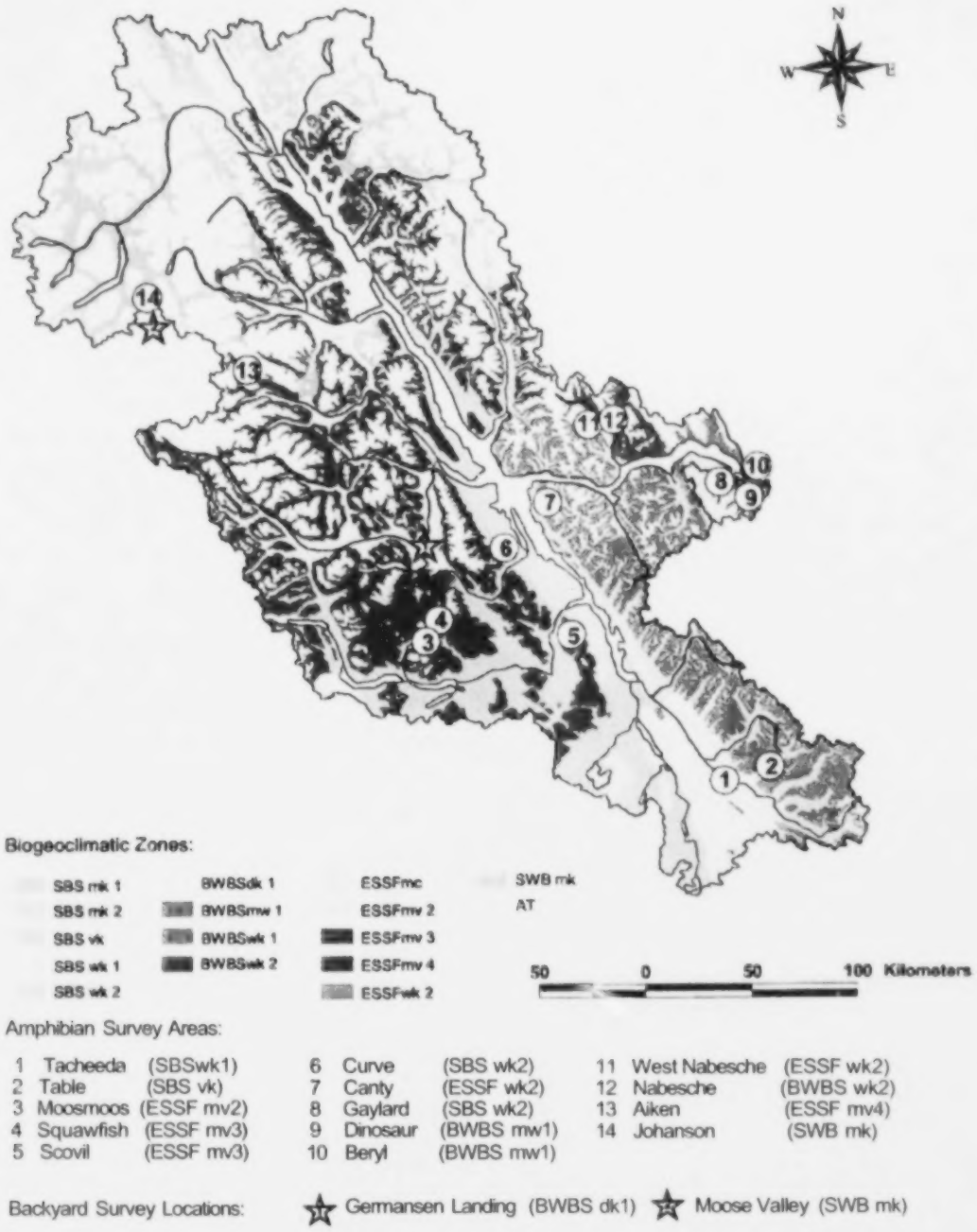

Figure 2. Biogeoclimatic zones of the Williston and Dinosaur Reservoir watersheds (BC Environment 1998). Survey areas selected for the 1999 PWFWCP amphibian reconnaissance surveys are identified.

3.0 Methods

3.1 1999 PWFWCP Amphibian Reconnaissance Surveys

3.1.1 Selection of Sampling Sites and Survey Timing

Areas were selected for the 1999 surveys based on their BGZ subunit designation and geographic location; previous amphibian presence and distribution data collected by the PWFWCP (Hengeveld 1999) and Slocan Group, Mackenzie Operations (unpublished) were also considered. The priority was to survey sites in BGZ subunits and geographic regions that lacked information on amphibians. The BWBS wk1 and ESSF mc units were not scheduled to be surveyed as they occupy only small, isolated portions of the watershed and were not easily accessible. Also, since previous surveys confirmed the presence of all four amphibian species expected to occur in the SBS mk1, mk2, and BWBS dk1 units (Hengeveld 1999; Slocan Group, Mackenzie Operations, unpublished), surveys were not scheduled for these units in 1999.

Prior to commencing the field work, BEC maps, 1:250,000 topographic maps, and Forest Service road maps were reviewed to identify appropriate survey areas in each BGZ subunit. Accessibility was a major consideration since most survey areas were to be accessed by road. Road access to SWB areas in the watershed was limited, so some of the survey sites selected in this zone were located up to 5 km outside of the watershed boundary. Sites in remote locations and not accessible by road were accessed by helicopter.

Specific sampling sites within each survey area were selected by the surveyors once they were in the field. Appropriate aquatic survey sites were considered to be any water body or wet meadow easily accessible from the road. Breeding call survey sites were identified, when possible, prior to the evening survey and were at least 500 m apart so that calls heard at one site would not also be heard at the next. Roadside wet areas with little or no running water present were considered to be optimal breeding call survey sites (i.e., minimal interference when listening for vocalizations), and were favoured unless only a small number of potential sites were present in the area.

Surveys were conducted as early in the spring as possible because amphibians occurring in the watershed (with the probable exception of western toads) may begin to breed while

lakes are still partially ice-covered and patchy snow remains on the ground (Cook 1984, Corkran and Thoms 1996). However, snow and soft roads early in the season, particularly in the more northerly and higher elevation areas, were restricting factors in terms of both site selection and survey timing. Amphibian activity reports from professionals and enthusiasts throughout northern BC, as well as local weather, snow, and road condition reports, were obtained from various sources to help guide decisions with respect to survey timing.

3.1.2 Sampling Methods

A combination of aquatic and breeding call surveys were used to maximize the possibility of detecting multiple amphibian species in an area (Hengeveld 1999). Both methods are useful for detecting the targeted frog and toad species during the breeding season. Long-toed salamanders, however, are non-vocal, thus only the aquatic surveys facilitate detection of this species. A single observation of eggs, larvae, juveniles, adults, and/or breeding calls indicated species presence at a site. The aim was to conduct as many aquatic and breeding call surveys in an area as necessary to detect all species expected to be present; however, the number of surveys conducted was limited by weather conditions and the number of days budgeted for field work. At some sampling sites, both types of survey were conducted.

Survey areas were named with reference to the nearest recognizable geographic feature. Sampling sites were referred to by their survey area name, with a number suffix to identify aquatic survey sites or a letter suffix for breeding call survey sites. Location co-ordinates (UTM, NAD83) were determined for each site using a Trimble Flightmate Pro hand-held Global Positioning System (GPS) unit. Site elevations were approximated from 1:50,000 topographic maps.

For all sampling sites, survey date and time, site location, local weather conditions (i.e., ambient temperature, wind speed and direction, cloud cover, and precipitation), and amphibian species encountered were noted. The identity of amphibian species observed was confirmed using the descriptions and keys in Corkran and Thoms (1996). Frog and toad breeding call recordings were also used as references: 'The Amphibians and Reptiles of Alberta' recorded by Cliff Wallis/Cottonwood Consultants (Calgary, AB), and recordings made by Sandra Kinsey (Prince George, BC). A copy of the data forms used is provided in Appendix A.

3.1.2.1 Aquatic Surveys

Aquatic surveys were conducted between mid-day and early evening, when amphibians are thought to be most active (Sandra Kinsey and Laird Law, Prince George, BC, personal communication). Two observers searched the shoreline and shallow water areas of each survey site, checking vegetation and turning over rocks and woody debris in an effort to find amphibian eggs, larvae, and adults. Individuals were captured with aquarium dipnets and held in a 4 L plastic bucket when necessary for species identification and photography. Adult snout-to-vent length (SVL) and larval measurements were taken with a 6-inch plastic ruler. In general, the observers searched separately at each site to maximize the area covered, assisting each other only when a specimen had been found. In some cases, only portions of a wetland were surveyed due to time and access limitations. Observers recorded their individual start and stop search times; the total search effort (number of person-hours) for each site was calculated by summing the individual observer search times.

Water temperature and pH were measured at each site, and site photographs were taken. Anecdotal information noted during the surveys included general habitat data (i.e., description of the aquatic substrate, type and amount of aquatic vegetation, shoreline characteristics, and general surroundings), the presence of water invertebrates and fish, and the progression of plant growth (e.g., shoot emergence, leaf budding and flushing). The presence of various site attributes and aquatic fauna may influence whether or not particular amphibians are present, while the flora phenology provides some indication of microclimate differences among survey areas.

3.1.2.2 Breeding Call Surveys

Breeding call surveys were conducted between dusk and midnight. At each site the vehicle was stopped and the ignition turned off. Observers stood on the road to listen, recording all amphibian calls heard within the standard 3 minute period, identifying both the species and the call frequency code[3] (NAAMP 1999). Amphibian calls heard after 3 minutes had elapsed, and other wildlife heard or observed during the survey, were also noted. For logistical reasons, breeding call surveys were not conducted at sites accessed by helicopter.

[3] The frequency of calls is recorded as 0 (no calls heard), 1 (no overlap in calls from a single species), 2 (calls of one species are overlapping but distinct), or 3 (full chorus of one species; calls continuous and overlapping, individuals not distinguishable).

For use as future reference material, some amphibian breeding calls heard while conducting the surveys were recorded using a small hand-held tape recorder.

3.2 *Backyard Amphibian and Reptile Surveys*

Backyard Amphibian and Reptile Survey packages were prepared and mailed to persons who had expressed interest in herptiles during the 1998 PWFWCP reconnaissance surveys. The packages contained survey instructions and data forms (adapted from the Peace River District Amphibian and Reptile Surveys[4]), species identification sheets, an audio tape of breeding call recordings, and in some cases, a recyclable camera (Appendix B). Observers were encouraged to record details of amphibian activity at a site (or sites) of their choice, between mid-April and early August, 1999.

3.3 *Slocan Group, Mackenzie Operations, Amphibian Inventory Project*

Slocan Group, Mackenzie Operations, conducted baseline amphibian inventory and monitoring surveys during the May to September period in 1995, 1996, and 1997. Their objective was to determine amphibian presence at selected sites, and estimate their distribution and relative abundance in the Mackenzie TSA (Leslie Yaremko, Slocan Group, Mackenzie, BC, personal communication). The 1995 season was a trial for amphibian monitoring, with a focus on long-toed salamander detection. In 1996 and 1997, additional sites were surveyed and amphibian breeding sites (identified in 1995 and 1996) were re-visited. At most sites, a combination of intense and casual survey methods were employed to survey both the wetland's shoreline and adjacent forest-floor habitat:

Perimeter search:	casual search of the wetland's perimeter, with a focus on areas of anticipated or known amphibian activity (e.g., favourable or previously identified breeding areas).
Transect survey:	*4* randomly-placed shoreline transects (one per compass quadrant) to survey 40% of the wetland's perimeter.
Visual encounter survey:	intensive, equal-effort survey (i.e., a fixed area searched in a fixed amount of time) of a randomly selected 10 m by 10 m plot in the forested habitat adjacent to the wetland.

In addition, pitfall traps (terrestrial) and minnow traps (aquatic) were used on a trial basis in 1995.

[4] Stan A. Orchard, co-ordinator. 1745 Bank Street, Victoria, BC V8R 4V7; e-mail sorchard@islandnet.com

4.0 Results

4.1 1999 PWFWCP Amphibian Reconnaissance Surveys

PWFWCP personnel conducted amphibian surveys in the Williston and Dinosaur Reservoir watersheds between 28 April and 19 August, 1999. Weather conditions were generally cool (0-15°C), with patchy snow remaining in most areas surveyed up to 11 June (Appendix C). Ninety-three (93) surveys were conducted at 84 sites in the SBS, BWBS, ESSF, and SWB zones (Table 1, Figure 2). Ten (10) BGZ subunits were surveyed, including 6 in the Parsnip region, 4 in the Peace region, and 2 in the Finlay region; the SBS wk2 and the ESSF wk2 were surveyed in both the Parsnip and Peace regions. No surveys were conducted in the Alpine Tundra zone due to high snowpack, poor access, and time limitations.

Wood frogs and spotted frogs were detected in all 3 geographic regions, western toads were detected in the Parsnip and Peace regions, long-toed salamanders were detected only in the Parsnip region, and striped chorus frogs were detected only in the Peace region (Table 1, Figure 3). At least one amphibian species was detected in every BGZ subunit surveyed except in the SWB mk. The SBS wk1 was the only sampling unit in which all amphibian species expected to be present (i.e., western toads, wood frogs, Columbia spotted frogs, and long-toed salamanders) were detected.

A total of 54.2 person-hours was spent conducting aquatic surveys at 49 sites within 10 BGZ subunits (Table 1). Aquatic survey sites were surveyed once, except for the Tacheeda 2 site (SBS wk1), which was surveyed on 5 occasions (4.7 person-hours total). The aquatic survey sites included a variety of wetland habitat types, ranging from small ephemeral pools, ditches, and flooded gravel pits to larger ponds, marshes, and extensive wet meadow complexes. Descriptions of the amphibians (individuals and egg masses) observed are provided in Appendix D.

Table 1. Amphibian species detected by aquatic (AQ) and breeding call (BC) surveys at sites in various biogeoclimatic zone (BGZ) subunits within the Williston and Dinosaur Reservoir watersheds, 28 April to 19 August, 1999.

Region	BGZ subunit	Survey Area	Number of Sites	Surveys[1] n	Type	Time Spent[2]	Species Detected[3]				
Parsnip	SBS vk	Table	11	7	AQ	10.5	BUBO		RALU		
				4	BC						
	SBS wk1	Tacheeda	14	8	AQ	11.7	BUBO	RASY	RALU		AMMA
				6	BC						
	SBS wk2	Curve	3	3	AQ	3.6		RASY			
	ESSF mv2	Moosmoos	1	1	AQ	1.5		RASY	RALU		
	ESSF mv3	Squawfish	1	1	AQ	1.1	BUBO		RALU		
		Scovil	2	2	AQ	0.9	BUBO				
	ESSF wk2	Canty	1	1	AQ	2.5					
Peace	SBS wk2	Gaylard	6	1	AQ	1.5					
				6	BC		BUBO	RASY	RALU		
	BWBS mw1	Dinosaur	4	1	AQ	0.6		RASY			
				3	BC			RASY			
		Beryl	10	3	AQ	3.1					
				8	BC			RASY		PSTR	
	BWBS wk2	Nabesche	4	4	AQ	3.4	BUBO				
	ESSF wk2	WestNab.	2	2	AQ	1.2	BUBO				
Finlay	ESSF mv4	Aiken	14	8	AQ	6.8			RALU		
				10	BC			RASY			
	SWB mk	Johanson	11	7	AQ	5.8					
				7	BC						
Total			84	93		54.2					

[1] Summing the number (n) of surveys for each survey type (aquatic and breeding call) does not necessarily equal the number of sites per survey area because both types of survey were conducted at some sites.

[2] Total combined search time (expressed in person-hours) for the aquatic surveys conducted in each survey area.

[3] Species code: long-toed salamander (*Ambystoma macrodactylum*, AMMA), western toad (*Bufo boreas*, BUBO), wood frog (*Rana sylvatica*, RASY), Columbia spotted frog (*Rana luteiventris*, RALU), striped chorus frog (*Pseudacris triseriata*, PSTR).

Evening breeding call surveys were conducted at 44 sites within *6* BGZ subunits (Table 1). During the evening surveys, breeding calls were only heard between 29 April and 11 May, with the exception of 2 wood frogs heard calling at the Aiken h site (ESSF mv4) on 28 May (Table 2). Breeding calls were also detected during aquatic surveys (between 1000 hrs and 1800 hrs) for wood frogs and striped chorus frogs at sites along the Beryl Prairie Road (BWBS mw1; 29 Apr), an individual wood frog at the Tacheeda 5 site (SBS wk1; 11 May), and individual toads calling as they bred at the Canty 1 site (ESSF wk2; 10 June) (Table 2). Evening breeding call surveys were not conducted in the Nabesche (BWBS wk2), West Nabesche (ESSF wk2), Canty (ESSF wk2), Moosmoos (ESSF mv2), Squawfish (ESSF mv3), and Scovil (ESSF mv3) areas as they were accessed by helicopter. Breeding call surveys were not attempted in the Curve Lake area (SBS wk2) due to high winds.

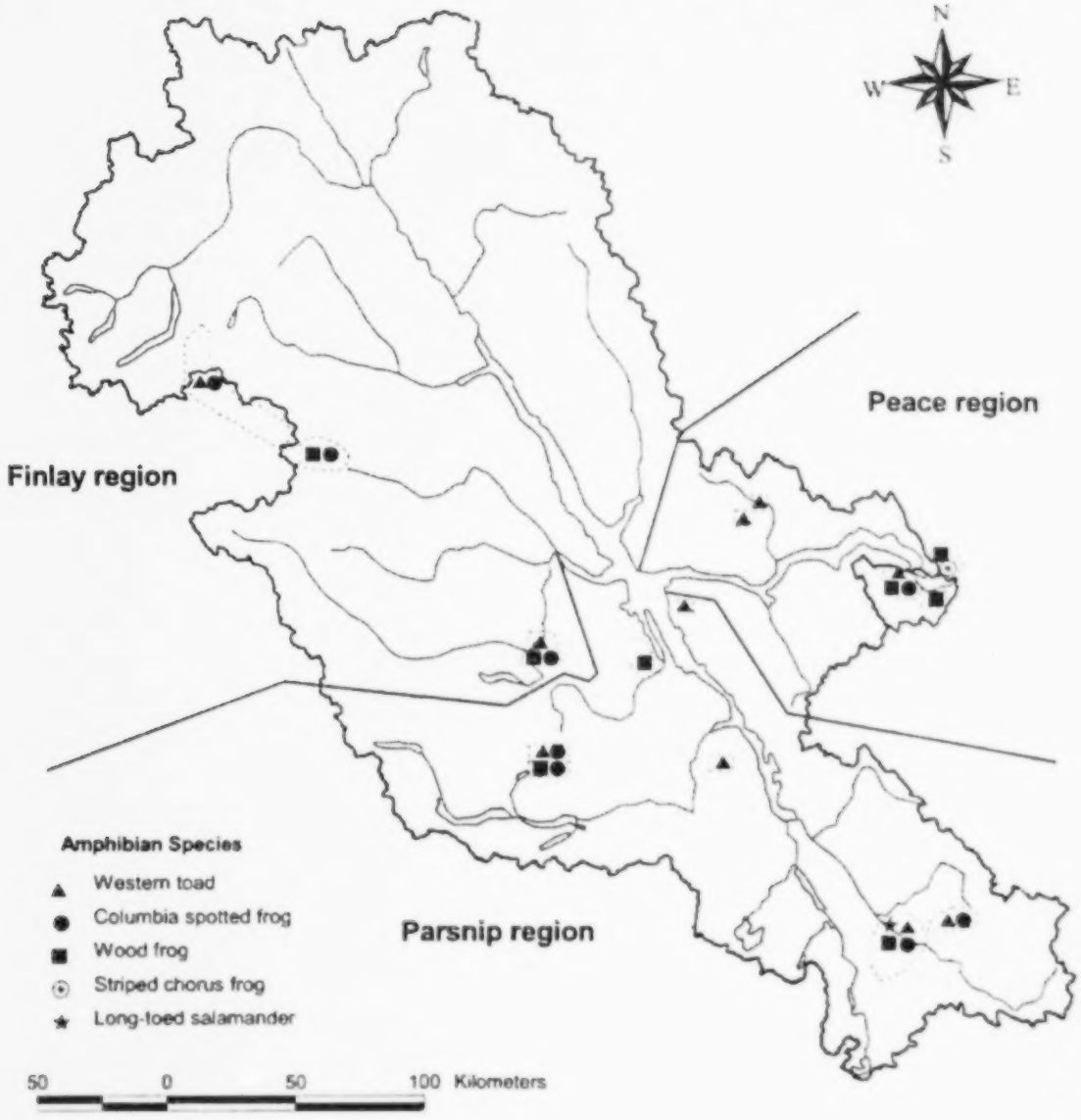

Figure 3. Amphibian species detected in the Williston and Dinosaur Reservoir watersheds during the PWFWCP amphibian reconnaissance surveys and Backyard Amphibian and Reptile Surveys, April - August 1999. The presence of a species symbol indicates at least one occurrence of the species in the survey area (outlined).

Table 2. Geographic distribution, life stage, and number of amphibians detected at sites in various biogeoclimatic zone (BGZ) subunits within the Williston and Dinosaur Reservoir watersheds, 28 April to 19 August, 1999.

					Amphibian Species Detected[2]									
					BUBO		RASY		RALU		PSTR		AMMA	
Region	BGZ subunit	Survey site[1]	Elev. (m)	Date	L.S.	n	L.S.	n	L.S.	n	L.S.	n	L.S.	n
Parsnip	SBS wk1	Tacheeda 2	750	10 May					E					
				23 May					Eh	1				
				11 Jun					L	>3			L	>10
									A	2				
				21 Jun									L	3
				19 Aug									L	4
		Tacheeda 5	750	11 May			C	1						
		Tacheeda 7	750	23 May	J	1			J	>5				
									A	1				
	SBS wk2	Curve 3	875	26 May			Eh	6						
	SBS vk	Table 3	825	24 May	J	3								
		Table 4	800	24 May					A	1				
		Table d	775	24 May	A	1								
		Table 6	775	25 May	J	1			E	1				
	ESSF mv2	Moosmoos 1	1,125	7 Jul			J	2	L	>5				
									A	2				
	ESSF mv3	Squawfish 1	1,175	7 Jul	J	1			L	>10				
		Scovil 2	1,500	7 Jul	A	2								
	ESSF vk2	Canty 1	1,300	11 Jun	E	>5								
					A	18[3]								
					C	1								
Peace	SBS wk2	Gaylard f	825	30 Apr	C	1	C	3	C	1				
	BWBS mw1	Dinosaur f	800	29 Apr			E	7						
		Dinosaur b	850	30 Apr			C	1						
		Beryl 1	800	29 Apr			A	>12						
							C	3						
		Beryl 2	800	29 Apr			C	1						
		Beryl 3 / Beryl c	725	29 Apr			C	3			C	3		
		Beryl a	725	29 Apr			C	1						
		Beryl d	725	29 Apr			C	2			C	3		
		Beryl e	725	29 Apr			C	3			C	3		
		Beryl f	725	29 Apr			C	2						
		Beryl g	750	29 Apr			C	1			C	1		
		Beryl h	750	29 Apr			C	2						
	BWBS wk2	Nabesche 4	1,000	10 Jun	J	1								
	ESSF wk2	WestNab 1	1,300	10 Jun	A	2								
		WestNab 2	1,300	10 Jun	A	1								
Finlay	ESSF mv4	Aiken 2	1,275	28 May					E	21-23				
									A	1				
		Aiken h	1,125	28 May			C	1						

[1] Survey site suffixes indicate the survey type used: aquatic survey (number) and breeding call survey (letter).

[2] Species: western toad (*Bufo boreas*, BUBO), wood frog (*Rana sylvatica*, RASY), Columbia spotted frog (*Rana luteiventris*, RALU), striped chorus frog (*Pseudacris triseriata*, PSTR), long-toed salamander (*Ambystoma macrodactylum*, AMMA).

Life stage (L.S.): egg (E), hatching eggs (Eh), larva (L), juvenile (J), adult (A), calling adult(C).

Abundance (n): based on direct counts or minimum estimates. For eggs, numbers refer to clusters of AMMA eggs, strings of BUBO eggs, and masses of RASY or RALU eggs. For calling amphibians, the 'number' is represented by the call frequency code: 1 (distinct, individual calls from one species), 2 (distinct but overlapping calls from one species), 3 (continuous and overlapping calls from one species).

[3] Seven of the 18 adult toads observed were dead, 1 from unknown causes and 6 freshly killed by a predator.

The only adult wood frogs observed in 1999 were a group of 12 sighted as they were calling in mid-afternoon at the Beryl 1 site on 29 April. Only 2 adult western toads were detected prior to the surveys conducted at the higher elevation sites (i.e., ESSF) in June and July (Table 2): 1 adult was heard calling at the Gaylard f site (SBS wk2; 30 Apr) and 1 adult was observed (but not heard calling) at the Table d site (SBS vk; 24 May).

Eight amphibian breeding sites, each in a different BGZ subunit, were identified based on the presence of eggs or larvae: Dinosaur 1 (BWBS mw1; wood frog), Tacheeda 2 (SBS wk1; Columbia spotted frog and long-toed salamander), Curve 3 (SBS wk2; wood frog), Table 6 (SBS vk; Columbia spotted frog), Moosmoos 1 (ESSF mv2; Columbia spotted frog), Squawfish 1 (ESSF mv3; Columbia spotted frog), Aiken 2 (ESSF mv4; Columbia spotted frog), and Canty 1 (ESSF wk2; western toad) (Table 2). A few eggs were taken from the Table 6 site on 25 May to confirm species identification; spotted frog larvae hatched from them in captivity on 2 June. Also, a single spotted frog egg was taken from the Aiken 2 site on 28 May; it hatched in captivity on 4 June. Western toad pairs were laying eggs at the Canty 1 site on 10 June.

Due to its ease of access and the presence of amphibian eggs on the initial visit (10 May), the Tacheeda 2 site was revisited on 4 occasions (23 May, 11 Jun, 21 Jun, 19 Aug) to monitor egg and larva development. The spotted frog eggs observed at the site on 10 May were hatching on 23 May. No long-toed salamanders, of any life stage, were detected at the Tacheeda 2 site during the initial survey on 10 May (when the shoreline debris and aquatic area were thoroughly searched), or during the subsequent visit on 23 May. However, when the site was visited a third time (11 June) to observe the spotted frog tadpoles, a few (>3) spotted frog tadpoles were located and, in addition, several (>10) salamander hatchlings were also found distributed throughout the site. Subsequent visits found only 3 long-toed salamander larvae on 21 June and, although most of the wetland had dried out, 4 long-toed salamander larvae (with little size or morphological change since 21 June) were located on 19 August.

4.2 Backyard Amphibian and Reptile Surveys

Backyard Surveys were conducted at two locations, both in the Finlay region: the Moose Valley airstrip in the Johanson Creek - Thutade Lake area (SWB mk), and the Muller residence at Germansen Landing (BWBS dk1) (Figure 2).

Ron Steffey surveyed two ponds (south pond 70 m by 20 m; north pond 110 m by 25 m), 20 m from each other, near the northwest end of the Moose Valley airstrip (Appendix E). His observations from 4 June to 16 July 1999 confirmed the presence of spotted frogs in the south pond and western toads in the north pond. A spotted frog egg mass was observed on 4 June, with hatchlings present in the mass on 14 June. A few grey-green tadpoles, some twice the size of others, were noted on 30 June and again on 16 July. More than 10,000 western toad tadpoles were estimated to be present in the north pond within 1 m of the shoreline on 30 June. The tadpoles, all black, occurred at varying densities throughout the pond. By 16 July, the pond had extensive dry areas and the tadpoles were becoming isolated in small pools.

Emily and Nerida Muller surveyed a pond (6 m by 4.5 m) adjacent to their residence at Germansen Landing. They monitored the activities of spotted frogs, wood frogs, and western toads from 30 April to 14 July 1999 (Appendix E). The first frogs they observed (species not specified) appeared sluggish and disoriented and may have come from small holes in the ground near the pond on 30 April; one mating pair laid eggs on that date. Spotted frogs were heard calling on 1 May, and egg masses were observed on several occasions: 11 May (6-7 egg masses), 12 and 19 May (8), and 26 May (about 6). Wood frog egg masses were observed on 12 May (1), 13 May (4), and 19 May (6). About 4 adult wood frogs were heard calling on 25 May. Western toads were calling on 1 May and one mating pair was observed on 13 May. On 19 May, 2 female western toads were observed laying eggs and about 4 egg strings were located. On 31 May, a common raven (Corvus corax) killed several mating western toad pairs and individual females with eggs. "Hundreds" of unidentified tadpoles were observed on 24 June, and approximately 20 were observed on 13 July.

Emily and Nerida noted that higher than normal flood levels on the Omineca River and unusually colder temperatures in the spring likely influenced the number and type of frogs and toads present. The floodwater swept many tadpoles away from the survey pond. Wood frogs and some spotted frogs moved from the survey pond to a seasonal swamp that develops during the spring flooding; the frogs were no longer seen once the floodwater subsided. Western toads were only in the pond when mating and laying eggs; adults later gathered under a raised platform nearby that is used as a helicopter pad. Juvenile toads were found at the pond's edge and in the garden, but rarely under the helicopter pad. By late July, many young spotted frogs and young toads were observed, but wood frogs were rarely seen.

4.3 Incidental Amphibian and Reptile Observations

Several records of incidental herptile observations were reported to the PWFWCP between April and August 1999 (Table 3). Noteworthy reports include the discovery of an inactive, adult long-toed salamander under 60 cm of snow on a residential property in Mackenzie (SBS wk2; central Parsnip region) on 25 April (Diane Smith, Mackenzie, BC). The property is adjacent to woodlands and approximately 100 m from a seasonal swamp that dries up in late summer.

Wood frogs were calling in choruses at Mugaha Marsh (SBS mk2; central Parsnip region) on 28 April (Vi and John Lambie, Mackenzie, BC). Spotted frog tadpoles were found at Squaw Lake (SBS mk1; southern Parsnip region) on 12 June (Mari Wood, Prince George, BC). Spotted frog or wood frog eggs were observed at two sites along the Finlay-Thutade FSR (SWB mk; northwestern Finlay region): eggs were present at the 412 km site between mid-June and late July, and eggs observed at the 448.25 km site were nearly hatching on 29 June (Kevin Wilkinson, Mackenzie, BC). Tadpoles were apparent at the 448.25 km site by 28 July.

Western toads observed at 49 km on the Tenakihi FSR (ESSF mv3; Finlay region) and along Two Lake Creek (ESSF mc; upper Sustut River area, about 20 km southwest of the Moose Valley Backyard Survey site) provide the only records for toads in northern ESSF zones this year.

Garter snakes *(Thamnophis sp.)* were incidentally observed at 5 locations in the Williston Reservoir watershed, all in the Parsnip region (Table 3).

Table. 3. Incidental amphibian and reptile observations reported to the PWFWCP, April to August 1999.

Date	Location	BEC unit	Species[1]	Number and Life Stage	Observer	Comments
25 Apr	Mackenzie townsite	SBS wk2	AMMA	1 adult	D. Smith	One adult found inactive on her lawn under 60 cm of snow (discovered as she was shoveling snow); site is adjacent to forested area and ~100 m from an ephemeral swamp.
28 Apr	Mugaha Marsh	SBS mk2	RASY	adults	V. and J. Lambie	Heard several groups calling; counted eleven adults in one group.
23 May	Tacheeda 7	SBS wk1	*Thamnophis* sp.	1 adult	K. Murphy and P. Hengeveld	Found on grassy shoreline of a pool containing juvenile and adult spotted frogs.
24 May	Table 1	SBS vk	*Thamnophis* sp.	1 adult	K. Murphy and P. Hengeveld	Found swimming in water-filled gravel pit.
25 May	Table 5	SBS vk	*Thamnophis* sp.	1 adult	K. Murphy and P. Hengeveld	Found in grass along roadside.
12 Jun	Squaw Lake 1	SBS mk1	RALU	1 adult and tadpoles	M. Wood	In channel off northwest end of Squaw Lk, northwest of Bear Lk.
	Squaw Lake 2	SBS mM	BUBO	1 juvenile	M. Wood	Observed on hiking trail near Squaw Lk, northwest of Bear Lk.
17 Jun	49 km Tenakihi FSR	ESSF mv3	BUBO	1 juvenile	K. Wilkinson	Observed in a washout on the road.
18 Jun - 28 Jul	380 km Finlay-Thutade FSR	ESSF mv4	RALU	7 adults	K. Wilkinson	Multiple marshy pools, all less than 1 m depth. Surroundings are 85-year-old pine and scrub poplar.
	412 km Finlay-Thutade FSR	SWB mk	RALU or RASY	eggs	K. Wilkinson	
29 Jun	448.25 km Finlay-Thutade FSR	SWB mk	RALU or RASY	eggs and tadpoles	K. Wilkinson	Many eggs in gravel pit. Some larvae moving within their eggs. Tadpoles appeared sometime between 29 June and 28 July.
5 Jul	Two Lake Crk, 8-10 km from confluence with Sustut R.	ESSF mc	BUBO	3 adults	R. Steffey	
12 Jul	Cutblock south of 4 km on the Manson FSR	SBS mk2	*Thamnophis* sp.	1 adult	R. Weir	
30 Jul	Floodplain at mouth of Manson R.	SBS mk2	BUBO	2 juveniles	R. Weir	
31 Jul	Road to Robert's Pond	SBS mk2	BUBO	1 adult	R. Weir	
1 Aug	3.5 km Manson Dump Rd.	SBS mk2	*Thamnophis* sp.	1 adult	R. Weir	
4 Aug	Osilinka R. valley	BWBS dk1	BUBO and RALU	tadpoles	C. Butt	Tadpoles (no limb buds).
			RALU	2 adults	C. Butt	
20 Aug	Bear Lake	SBS mk1	BUBO	toadlets	K. Hanson	Thumbnail sized toads found all over the beach.

[1] Species code: long-toed salamander *(Ambystoma macrodactylum,* AMMA); western toad *(Bufo boreas,* BUBO); wood frog *(Rana sylvatica,* RASY); Columbia spotted frog *(Rana luteiventris,* RALU); garter snake *(Thamnophis* sp.).

4.4 Summary: *Presence and Distribution of Amphibians in the Williston and Dinosaur Reservoir Watersheds*

From 1995 through 1997, Slocan Group, Mackenzie Operations, conducted amphibian inventory and monitoring activities at 46 sites (Williston Reservoir watershed); these sites represented 6 BGZ subunits (Table 4). Twenty-one of the sites where amphibians were detected in 1995 and 1996 were re-visited in subsequent years, In 1998 and 1999 combined, the PWFWCP conducted 102 breeding call surveys and 70 aquatic surveys at 143 sites within 13 BGZ subunits in the Williston and Dinosaur Reservoir watersheds (Table 4). In addition, Backyard Amphibian and Reptile Surveys were conducted at 2 locations in 1999, and incidental amphibian sightings reported to the PWFWCP in 1998 and 1999 identified amphibian presence at 20 locations (Table 4). Twenty-eight (28) sites were surveyed by more than one source and/or in more than one year, thus the total number of unique sites was 206.

Western toads, wood frogs, Columbia spotted frogs, and long-toed salamanders were commonly observed in the SBS mk, SBS wk, and BWBS dk subzones (Tables 5 and 6).

Table 4. Survey sites in various biogeoclimatic zone (BGZ) subunits within the Williston and Dinosaur Reservoir watersheds, 1995 - 1999. Data were compiled from the PWFWCP (1998 and 1999 reconnaissance survey results and incidental reports, and 1999 Backyard Survey data), and Slocan Group, Mackenzie Operations (1995 - 1997 amphibian inventories, unpublished data).

			Sites by BGZ Subunit[1]														
			SBS					BWBS				ESSF				SWB	
Year	Source	Sites	mk1	mk2	wk1	wk2	vk	dk1	mw1	wk1	wk2	mc	mv2	mv3	mv4	wk2	mk
1995	Slocan Group	9	3	3		1		2									
1996	Slocan Group	21	6	6		5		3							1		
1997	Slocan Group	38	9	7		5		15						1	1		
1998	PWFWCP	59	14	10		17		11	7								
	Incidental reports	8	2	4		1				1							
1999	PWFWCP	84			14	9	11		14		4		1	3	14	3	11
	Backyard Surveys	2						1									1
	Incidental Reports	13	2	4				1				1		1	1		2
	Total[2]	206	31	26	14	32	11	27	20	1	4	1	1	5	15	3	14

Biogeoclimatic zones: Sub-Boreal Spruce (SBS); Boreal White and Black Spruce (BWBS); Engelmann Spruce - Subalpine Fir (ESSF); Spruce-Willow-Birch (SWB). The first letter of the two letter code for BGZ subunits refers to precipitation: x (very dry/xeric); d (dry); m (moist); w (wet); v (very wet). The second letter refers to temperature: h (hot); w (warm); m (mild); k (cool); c (cold); v (very cold). Variants are named by geographic area within a zone, and ordered by increasing number from south to north and from west to east (DeLong et al. 1994).

Twenty-eight sites were surveyed by more than one source and/or in more than one year, thus the total number of unique sites was 206.

Table 5. Amphibian species presence in biogeoclimatic zone (BGZ) subunits within the Williston and Dinosaur Reservoir watersheds, 1995 - 1999. Data were compiled from the PWFWCP (1998 and 1999 reconnaissance survey results and incidental reports, and 1999 Backyard Survey data), and Slocan Group, Mackenzie Operations (1995 - 1997 amphibian inventories,unpublisheddata).

	BGZ Subunit[1]														
	SBS					BWBS				ESSF					SWB
Species	mk1	mk2	wk1	wk2	vk	dk1	mw1	wk1	wk2	mc	mv2	mv3	mv4	wk2	mk
Western toad	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔		✔		✔	✔
Wood frog	✔	✔	✔	✔		✔	✔	✔			✔		✔		
Columbia spotted frog	✔	✔	✔	✔	✔	✔	✔				✔	✔	✔		✔
Striped chorus frog							✔								
Long-toed salamander	✔	✔	✔	✔		✔									

[1] Biogeoclimatic zones: Sub-Boreal Spruce (SBS); Boreal White and Black Spruce (BWBS); Engelmann Spruce - Subalpine Fir (ESSF); Spruce-Willow-Birch (SWB). The first letter of the two letter code for BGZ subunits refers to precipitation: x (very dry/xeric); d (dry); m (moist); w (wet); v (very wet). The second letter refers to temperature: h (hot); w (warm); m (mild); k (cool); c (cold); v (very cold). Variants are named by geographic area within a zone, and ordered by increasing number from south to north and from west to east (DeLong et al. 1994).

Western toads and Columbia spotted frogs were more prevalent than wood frogs at sites in the higher elevation zones, ESSF and SWB; long-toed salamanders were not detected in either of these zones. Striped chorus frogs were only located at sites in the lowland BWBS mw1.

Western toads, wood frogs, and Columbia spotted frogs were widely distributed throughout the three geographic regions of the Williston and Dinosaur Reservoir watersheds (Table 6, Figures 4 to 6). Striped chorus frogs were marginally present, detected only along the Beryl Prairie road at Hudson's Hope (Peace region; Table 6, Figure 7). Long-toed salamanders were primarily observed in the Rocky Mountain Trench, at low-elevation sites around the Williston Reservoir (Parsnip and Finlay regions; Table 6, Figure 8).

Based on the presence of amphibian eggs and larvae, 33 breeding sites were identified in the Williston and Dinosaur Reservoir watersheds, with several sites being used by multiple species: western toads (12), wood frogs (6), Columbia spotted frogs (18), and long-toed salamanders (5) (Table 6; Appendix F). Breeding calls were heard at an additional 29 sites, including striped chorus frog calls at 5 sites near Hudson's Hope. From 1995 to 1999, the earliest date that eggs were observed was 29 April, 1999 (wood frog; Dinosaur 1 site, BWBS mw1, eastern Peace region) and the latest date was 29 June, 1999 (unclassified frog; 448.25 km on the Finlay-Thutade FSR, SWB mk, northern Finlay region) (Appendix G).

Table 6. Geographic distribution and life stage of amphibians detected at sites in various biogeoclimatic zone (BGZ) subunits within the Williston and Dinosaur Reservoir watersheds, 1995 - 1999. Data were compiled from the PWFWCP (1998 and 1999 reconnaissance survey results and incidental reports, and 1999 Backyard Survey data), and Slocan Group, Mackenzie Operations (1995 - 1997 amphibian inventories, unpublished data).

BGZ subunit	Region	Area	Survey Site	Amphibian Species and Life Stage Detected										Data Source
				EUBO		RASY		RALU		PSTR	AMMA		UNID	
SBS mk1	Parsnip	Bear Lk	Squaw Lake 1					L	A					This study
			Squaw Lake 2		J									This study
			Bear Lake		J									This study
		Sabini FSR	A2		C									Hengeveld 1999
			A3		C									Hengeveld 1999
			A6		J				C					Hengeveld 1999
			A11		A						E			Hengeveld 1999
			A14						C					Hengeveld 1999
			Philip 6		A		A					A		Slocan Group
		Philip FSR	Philip1		J	A			J	A				Slocan Group
			Philip 2				J	A						Slocan Group
			Philip 3						A			J	A	Slocan Group
			Philip 4			E			A					Slocan Group
		Nation FSR	Blackwater 6		A				A					Slocan Group
			Blackwater 8						A					Slocan Group
			Blackwater 10					E	L		E	J		Slocan Group
			Wolverine 5000 FSR						A				L	Hengeveld 1999
		Manson P	Manson 12000 FSR										L	Hengeveld 1999
SBS mk2	Parsnip	Mugaha	Mackenzie 2		J		A	E	A			A		Slocan Group
			Mackenzie 3 / G2 / Mugaha Marsh	E	L	J	A	A	C	E	A	J	A	Slocan Group; Hengeveld 1999, this study
		Blackwater Crk	Blackwater 3 / B3	E	L	J	A	C	A	C				Slocan Group; Hengeveld 1999
			Blackwater 5	E		A								Slocan Group
			B4			A					E			Hengeveld 1999
			B6			C			C					Hengeveld 1999
			C1								E			Hengeveld 1999
			Blackwater 1000 FSR						A					Hengeveld 1999
			Bug Lk Rd						A					Hengeveld 1999
		Manson R	Mouth of Manson River		J									This study
			Robert's Pond		A									This study
		Strandberg	Strandberg		J		J						A	Hengeveld 1999
	Fraser	Ospika R	Ospika 1	L	A		J							Slocan Group
			Ospika 2						A					Slocan Group
			Ospika 3					L	J	A				Slocan Group

Table 6. *continued.*

BGZ subunit	Region	Area	Survey Site	Amphibian Species and Life Stage Detected						Data Source
				BUBO	RASY	RALU	PSTR	AMMA	unkn	
SBS vk	Parsnip	Table R	Table 3	J						This study
			Table 4			A				This study
			Table 5	A						This study
			Table 6	J		E				This study
SBS wk1	Parsnip	Tacheeda Lks	Tacheeda 2			E L A		L		This study
			Tacheeda 5		C					This study
			Tacheeda 7	J		J A				This study
SBS wk2	Parsnip	Mackenzie	Mackenzie 1 / Townsite					J A		Slocan Group this study
		Curve Lk	E5	C						Hengeveld 1999
			E7			C				Hengeveld 1999
			F2			C				Hengeveld 1999
			Curve 3		E					This study
	Peace	Clearwater FSR	Clearwater 1	A						Slocan Group
			Clearwater 4	A		A				Slocan Group
		Nabeschie R	Mt Brewster	A						Hengeveld 1999
		Gaylard Crk	J1		A					Hengeveld 1999
			J3 / Gaylard 1	L C	C	C				Hengeveld 1999 this study
BWBS dk1	Finlay	Germansen	D2 / Germansen Landing	E J A C	E J A C	E J A C		A		Hengeveld 1999 this study
			D3		C	C				Hengeveld 1999
			D4		A C	E				Hengeveld 1999
			D9		C					Hengeveld 1999
			D11		C					Hengeveld 1999
		Osilinka R	Osilinka R	L		L A				This study
		Buffalo Head	Buffalohead 1	E	E L	A E				Slocan Group
			Buffalohead 2					A		Slocan Group
			Buffalohead 4	J	E	J A E	J A			Slocan Group
			Buffalohead 5	A						Slocan Group
			Buffalohead 6		A			A		Slocan Group
			Buffalohead 8		A					Slocan Group
			Buffalohead 12			E A				Slocan Group
			Buffalohead 13	J						Slocan Group
			Buffalohead 15		A	A				Slocan Group

continued

Table 6. *continued.*

BGZ subunit	Region	Area	Survey Site	Amphibian Species and Life Stage Detected: BUBO	RASY	RALU	PSTR	AMMA	uncl	Data Source
BWBS mw1	Peace	Johnson FSR	K6	J	A					Hengeveld 1999
			Dinosaur 1 / K4	L	E	A				Hengeveld 1999, this study
			Dinosaur b		C					This study
		Hudson's Hope	Beryl 1		A C					This study
			Beryl 2		C					This study
			Beryl a		C					This study
			Beryl c - Beryl 3		C		C			This study
			Beryl d		C		C			This study
			Beryl e		C		C			This study
			Beryl f		C					This study
			Beryl g		C		C			This study
			Beryl h		C					This study
BWBS wk1	Peace	Butler Ridge	Ruddy Crk	J	A					Hengeveld 1999
BWBS wk2	Peace	Nabesche R	Nabesche 4	J						This study
ESSF mc	Finlay	Sustut R	Two Lake Crk	A						This study
ESSF mv2	Parsnip	Mansmuch Crk	Mansmuch 1		J	L A				This study
ESSF mv3	Parsnip	Squawfish Lk	Squawfish 1	J		L				This study
		Mt. Scovil	Scovil 2	A						This study
		Sylvester Crk	Blackwater 11	E L		E				Slocan Group
	Finlay	Osilinka R	Tenakihi FSR	J						This study
ESSF mv4	Finlay	Aiken Lk	Aiken 1 / Thutade 390			A				This study
			Aiken 2			E				This study
			Aiken b		C					This study
ESSF wk2	Parsnip	Canty Lk	Canty 1	E A						This study
	Peace	West Nabesche R	WestNab 1	A						This study
			WestNab 2	A						This study
SWB mk	Finlay	Johansson Lk	Morse Valley	L A		E L				A This study
			Thutade 412						E	This study
			Thutade 448						E L	This study

[1] Name of survey site as assigned by the observer. Some sites have multiple names (e.g., Mackenzie 3 / G2 / Mugaha Marsh).

[2] Species: western toad (Bufo *boreas*, BUBO); Columbia spotted frog *(Rana luteiventris* , RALU); wood frog *(Rana sylvatica*, RASY); striped chorus frog *(Pseudacris triseriata*, PSTR); long-toed salamander *(Ambystoma macrodactylum, AMMA)*; unknown (unclassified, *uncl*). Life stage: eggs (E), larvae (L), juvenile (J), adult (A), calling adult (C).

[3] Identified as an unclassified frog (i.e., either wood frog or Columbia spotted frog).

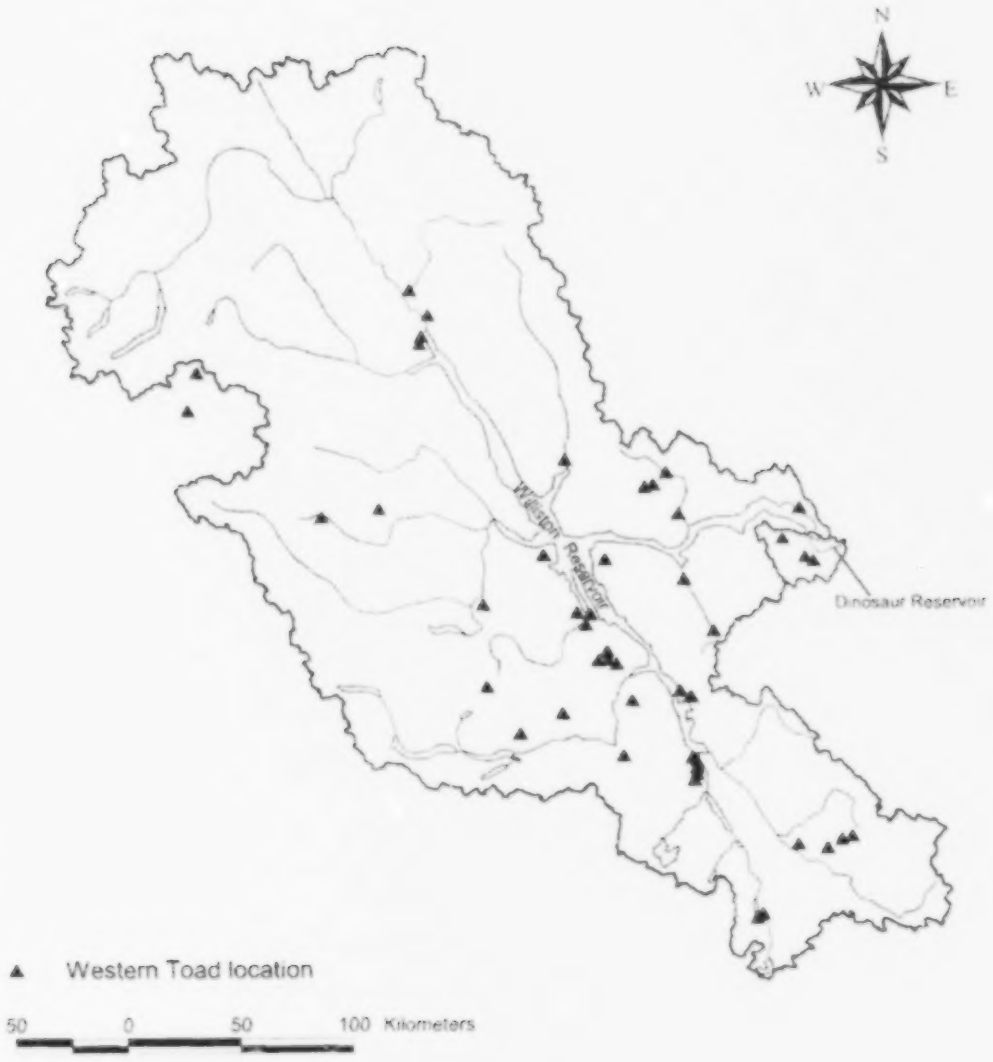

Figure 4. Presence of western toads *(Bufo boreas)* in and adjacent to the Williston and Dinosaur Reservoir watersheds, 1995 - 1999. Data were compiled from the PWFWCP (1998 and 1999 reconnaissance survey results and incidental reports, and 1999 Backyard Survey data), and Slocan Group, Mackenzie Operations (1995 - 1997 amphibian inventories, unpublished data). Symbol represents species presence at individual wetland sites.

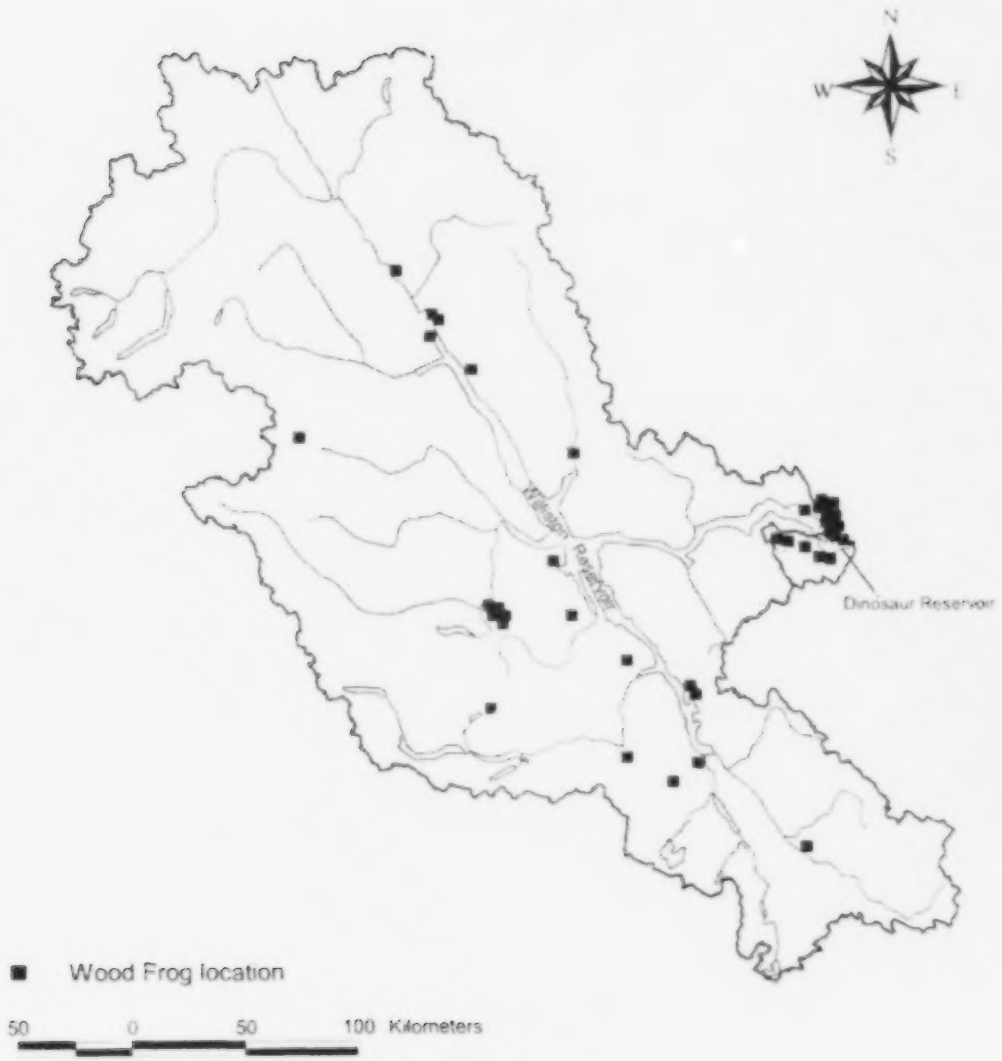

Figure 5. Presence of wood frogs *(Rana sylvatica)* in and adjacent to the Williston and Dinosaur Reservoir watersheds, 1995 • 1999. Data were compiled from the PWFWCP (1998 and 1999 reconnaissance survey results and incidental reports, and 1999 Backyard Survey data), and Slocan Group, Mackenzie Operations (1995 - 1997 amphibian inventories, unpublished data). Symbol represents species presence at individual wetland sites.

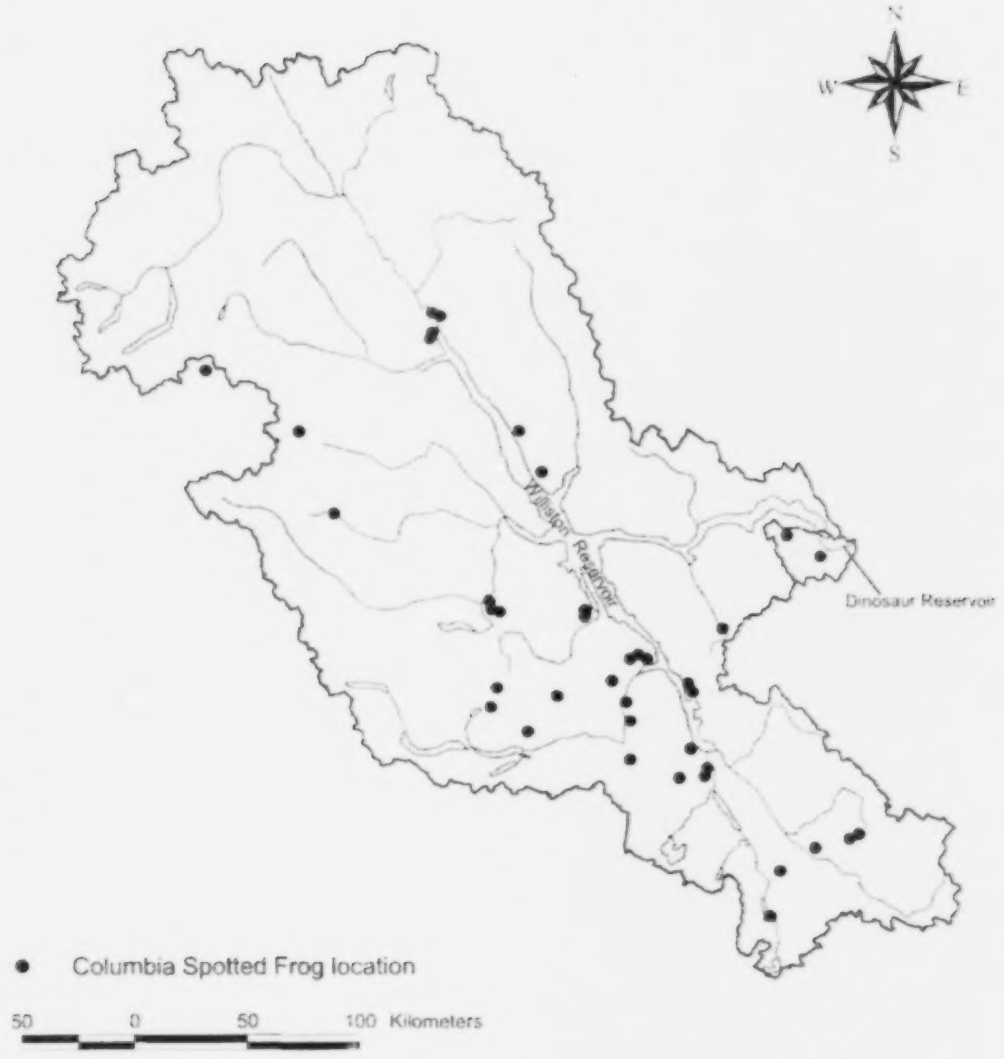

Figure 6. Presence of Columbia spotted frogs *(Rana luteiventris)* in and adjacent to the Williston and Dinosaur Reservoir watersheds, 1995 - 1999. Data were compiled from the PWFWCP (1998 and 1999 reconnaissance survey results and incidental reports, and 1999 Backyard Survey data), and Slocan Group, Mackenzie Operations (1995 - 1997 amphibian inventories, unpublished data). Symbol represents species presence at individual wetland sites.

Figure 7. Presence of striped chorus frogs *(Pseudacris triseriata)* in and adjacent to the Williston and Dinosaur Reservoir watersheds, 1995 - 1999. Data were compiled from the PWFWCP (1998 and 1999 reconnaissance survey results and incidental reports, and 1999 Backyard Survey data), and Slocan Group, Mackenzie Operations (1995 - 1997 amphibian inventories, unpublished data). Symbol represents species presence at individual wetland sites.

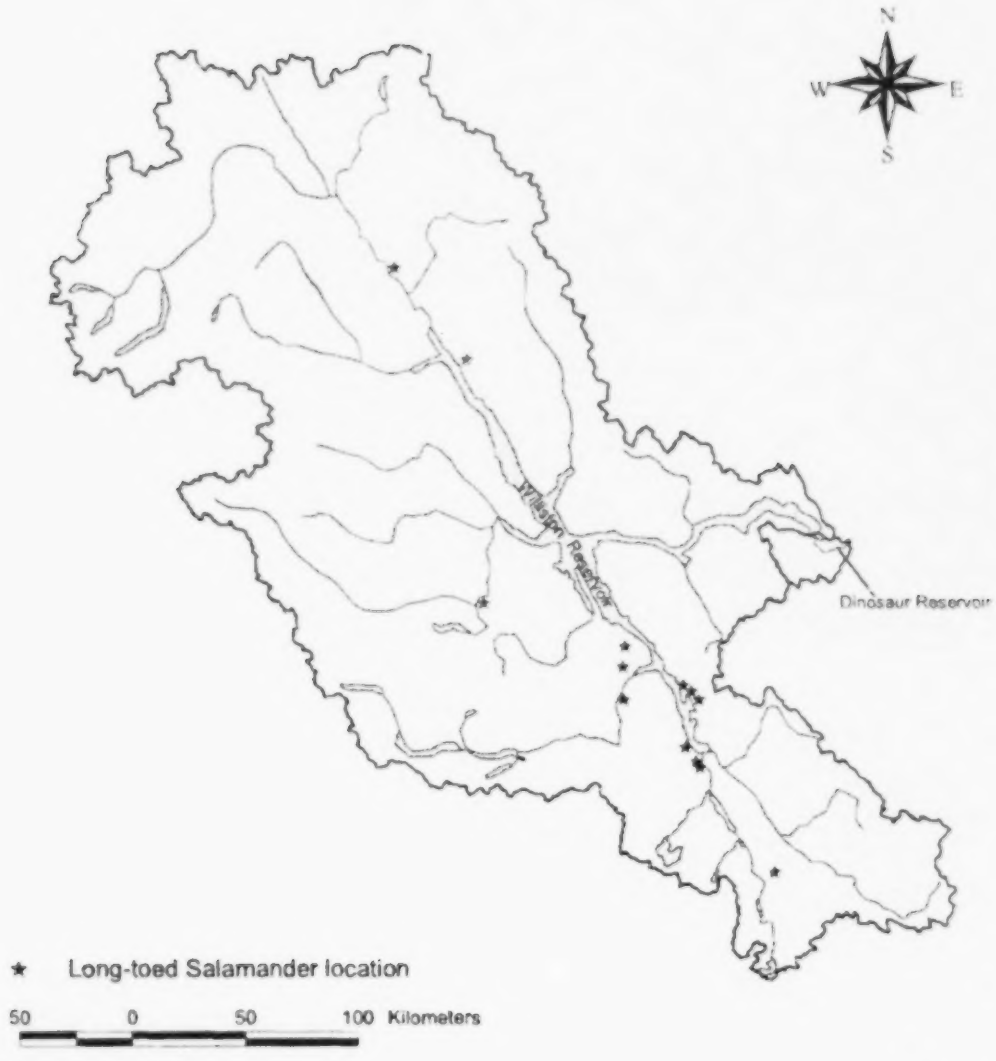

Figure 8. Presence of long-toed salamanders *(Ambystoma macrodactylum)* in and adjacent to the Williston and Dinosaur Reservoir watersheds, 1995 - 1999. Data were compiled from the PWFWCP (1998 and 1999 reconnaissance survey results and incidental reports, and 1999 Backyard Survey data), and Slocan Group, Mackenzie Operations (1995 -- 1997 amphibian inventories, unpublished data). Symbol represents species presence at individual wetland sites.

5.0 Discussion

Amphibians in the Williston and Dinosaur Reservoir watersheds are distributed across a range of geographic areas and biogeoclimatic units. Western toads, wood frogs, and Columbia sported frogs are found throughout most of BC (Green and Campbell 1984, Corkran and Thoms 1996), thus their presence and widespread distribution in our study area was expected.

Striped chorus frogs have only been reported to occur in the northeastern portion of the province (i.e., on the lee side of the Rocky Mountains) (Green and Campbell 1984, Corkran and Thoms 1996). Meidinger and Pojar (1991) noted that in BC this species is restricted to the BWBS of the Alberta Plateau (i.e., BWBS mw). This was supported by our findings as striped chorus frogs were only detected at sites along the Beryl Prairie road (BWBS mw1) near Hudson's Hope.

Long-toed salamanders were detected primarily at sites in the Rocky Mountain Trench (i.e., lowlands adjacent to the Williston Reservoir). This species has a patchy distribution throughout much of southern and central BC, and our study area is at the northern extent of this species' documented range (Nussbaum et al. 1983, Green and Campbell 1984, Corkran and Thoms 1996). There was only one previous record of long-toed salamander presence north of the Omineca and Peace Rivers (Nussbaum et al 1983, Green and Campbell 1984); long-toed salamander observations in the Finlay region provide new northern locality records for this species. Though long-toed salamanders were not detected during the amphibian surveys in the Peace region, their presence at survey sites in the Parsnip region and previous records of long-toed salamander presence along the lower Peace River (Nussbaum et al 1983, Green and Campbell 1984) suggest that they are present in the Peace region as well. Long-toed salamanders were not detected at higher elevation sites (ESSF and SWB zones). Slocan Group, Mackenzie Operations, used methods targeting the detection of this species, but only surveyed 2 sites in the ESSF; no long-toed salamanders were found. The survey methods employed by the PWFWCP were reconnaissance-level techniques to detect multiple amphibian species. Although the PWFWCP conducted spring aquatic surveys at 22 sites in the ESSF and SWB zones, salamander eggs and larvae can easily be missed using this method if the entire site is not thoroughly searched; salamander eggs are laid individually or in small clumps and larvae tend to stay congregated where eggs were laid (Mark

Thompson, Calgary, AB, personal communication). Aquatic surveys are not likely to detect adult salamanders, which have secretive, nocturnal, and predominantly terrestrial habits outside the breeding season. More intensive species- and habitat-specific survey methods may be more effective census techniques for this species (e.g., the pitfall trapping and transect survey methods tested by Slocan Group, Mackenzie Operations). It is possible, however, given that the species is at the northern extent of its range, that long-toed salamanders are absent entirely from colder areas in the watersheds (i.e., higher elevation zones).

The predominance of species detection in the SBS mk and wk subzones and the BWBS dk subzone may be a function of survey intensity, amount of surveyable area, and, to some extent, study area topography. Road access (particularly in the Parsnip region) facilitates surveys at sites in these subzones and increases the likelihood of incidental amphibian sightings. These units cover fairly extensive areas and, as they are lower elevation subzones in the watershed, likely provide warmer and a greater number of wetland sites suitable for amphibians. The SBS vk (Parsnip region) and BWBS mw and wk (Peace Region) subzones occupy much smaller and/or isolated portions of the watersheds. There are few records for amphibian presence in higher elevation sites, likely due to the limited number of surveys that have been conducted to date in the ESSF and SWB zones, and the absence of inventories conducted in the AT zone. Therefore, reports submitted by the public (i.e., Backyard Survey reports and incidental sightings) can provide invaluable information on amphibians in remote portions of the watersheds; several of the ESSF and SWB records for this study were contributed through these means.

The breeding period for amphibians in the Williston and Dinosaur Reservoir watersheds appears to be between late April and the end of June, depending on geographic location, elevation, and annual weather conditions. Adults of the 5 amphibian species known to occur in the Williston and Dinosaur Reservoir watersheds congregate at breeding sites for only a short time each spring, and typically disperse from the sites soon after eggs are laid. Wood frogs, spotted frogs, striped chorus frogs, and long-toed salamanders may begin breeding while patchy snow remains on the ground and larger lakes are still partially ice-covered, but the onset of breeding is difficult to predict and, for some species (e.g., wood frogs), may last only a few days (Cook 1984, Green and Campbell 1984, Corkran and Thoms 1996). Western toads breed in mid-spring (Corkran and Thoms 1996), and thus might be expected to congregate and become vocal at aquatic

sites later than other amphibian species. Western toads and Columbia spotted frogs may have appeared to be more prevalent than wood frogs at sites in the higher elevation ESSF and SWB zones because these zones were not visited until late spring (i.e., June and July 1999); wood frogs may already have dispersed from wetlands.

The chronologies of egg deposition, egg hatching, and larval development vary among species and with site microclimate. Western toad, wood frog, and spotted frog eggs may hatch in 3 to 12 days, 7 days, and 15 days respectively (Brian Slough, Whitehorse, YK, personal communication). Long-toed salamander eggs hatch in approximately two and a half weeks at elevations below 2,200 m (Mark Thompson, Calgary, AB, personal communication). Western toad and long-toed salamander development is particularly sensitive to ambient conditions (Cook 1984; Jay Bowerman, Sunriver, OR, personal communication; Mark Thompson, Calgary, AB, personal communication). For all species, the chronologies can be expected to progress later at more northerly latitudes and higher elevations due to inherently cooler weather conditions.

The combination of aquatic survey and breeding call survey methods employed by the PWFWCP was useful for identifying amphibian species presence in the study area. Though the success of breeding call surveys is dependent on optimal survey timing (i.e., the survey coincides with the peak breeding period of species present at the site), this technique was an important component of the PWFWCP's reconnaissance surveys. Breeding call surveys enabled the detection of striped chorus frogs and were also useful for detecting wood frogs, two species which call prominently but may be difficult to observe. Aquatic surveys were more effective than breeding call surveys for the detection of Columbia spotted frogs and western toads, and were the primary method used to detect long-toed salamanders. Columbia spotted frogs have quiet, inconspicuous calls, western toads may only call irregularly, if at all (Brian Slough, Whitehorse, YK, personal communication; Laura Friis, Victoria, BC, personal communication), and long-toed salamanders are non-vocal. The detection of frog and toad breeding calls during the PWFWCP's daytime aquatic surveys as well as during the evening breeding call surveys suggests that breeding call surveys need not be limited to the hours between dusk and midnight.

Further surveys may be warranted to elucidate amphibian species presence and distribution in higher elevation localities throughout the watersheds. While single-visit reconnaissance surveys that use a combination of techniques are somewhat effective for obtaining baseline presence and distribution data for multiple amphibian species, the

value of repeated sampling at a site is immeasurable. This is perhaps of particular importance for amphibians as they can experience dramatic population fluctuations from year to year. Repeated sampling at a site not only ameliorates the species detection rate and boosts the confidence in the survey results, but also provides breeding and development chronology data, and enables observers to detect changes in amphibian populations and habitat over time.

6.0 Conclusion

Amphibian species presence and distribution within the Williston and Dinosaur Reservoir watersheds was concurrent with available literature, except for a possible elevational distribution restriction for long-toed salamanders. This exception may, however, be a function of survey timing and methodology, or reflect long-toed salamander distribution at the northern extent of this species' documented range in BC.

Biogeoclimatic zones and subunits appear to be useful as a sampling unit for determining landscape-level distribution of amphibians, but there is considerable variation in subunit and site variables. This variation is compounded by the variability in species detection, which is influenced by sampling methods and survey timing, thus with a low sampling intensity (e.g., a single visit) it is difficult to derive any conclusions about the apparent absence of a species from a survey area or site.

7.0 Acknowledgements

Many thanks to Rod Backmeyer, Harold Bent, Margo Boyle, Jackie Caldwell, Wayne Crossland, Andrew DeVries, Steve Dowling, Sandra Kinsey, Jeff Kotowsky, Vi Lambie, Laird Law, Scott Mueller, Jim Tuck, Robert Westcott, Leslie Yaremko, and Huguette Zuehlke, for their patience with my questions and for providing site access, road condition, local weather, and amphibian activity reports prior to the surveys.

Mari Wood and Fraser Corbould provided assistance with project planning and preparation. Doug Heard provided helpful input with respect to survey design. Kevin Murphy was contracted to assist with the fieldwork from 28 April to 31 May, 1999. Fraser Corbould assisted with the 10-11 June and 7 July surveys.

Emily Muller, Nerida Muller, and Ron Steffey submitted valuable Backyard Amphibian and Reptile Survey observations.

Reports of incidental amphibian and reptile sightings were gratefully received from Christy Butt, Kristina Hanson, Vi Lambie, John Lambie, Diane Smith, Ron Steffey, Richard Weir, Kevin Wilkinson, and Mari Wood.

Leslie Yaremko provided unpublished amphibian presence and distribution data collected by Slocan Group, Mackenzie Operations.

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Fraser Corbould's critical review of earlier drafts of this report is acknowledged with sincerest gratitude. Kevin Murphy, Leslie Yaremko, and Ed Hill also provided helpful comments on the manuscript.

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Appendix A. PWFWCP Amphibian Reconnaissance Survey Data Forms, 1999: visual (aquatic) site survey and auditory (breeding call) survey.

PWFWCP AMPHIBIAN SURVEY DATA FORM Visual site survey

DATE_____TIME START_____END_____OBSERVERS_____

WEATHER SKY clear | overcast (%) | rain_____
WIND calm | light | strong [Beaufort wind scale_____]
AIR TEMP_____24hr max & min_____

SITE#_____ at km_____on the_____ROUTE

SITE TYPE marsh | meadow | pond | lake | flood pool | ditch | stream | swamp
Description (substrate, aquatic veg type and % cover, shoreline) _____
_____
_____
_____
_____PHOTOS_____
SITE SIZE (m) length_____width_____max depth (> or < 1m)_____
WATER TEMP_____WATER pH_____

DESCRIPTION OF SURROUNDINGS (forest cover, type, age, etc.)_____
_____
_____

ELEVATION_____BEC ZONE_____variant_____
MAP_____UTM ZONE_____NORTHING_____EASTING_____

SPECIES	ADULTS	EGGS	TADPOLES	JUVENILES	OBS. REC #	PHOTO #

NOTES (microhabitat used, phib behaviour, other species)_____
_____
_____
_____
_____
_____
_____
_____
_____

PWFWCP AMPHIBIAN SURVEY **DATA** FORM Auditory survey

DATE_____TIME START_____END_____OBSERVERS_____

WEATHER SKY clear | overcast (%) | rain_____
WIND calm | light | strong [Beaufort wind scale_____]
AIR TEMP_____24hr max & min_____

SITE#_____ at km_____on the_____ROUTE

SITE TYPE marsh | meadow | pond | lake | flood pool | ditch | stream | swamp
description_____

DIST FROM ROAD (m)_____ PHOTOS_____
SITE SIZE (m) length_____width_____max depth (> or < 1m)_____

DESCRIPTION OF SURROUNDINGS (forest cover, type, age, etc.)_____

ELEVATION_____ BEC ZONE_____variant_____
MAP_____UTM ZONE_____NORTHING_____EASTING_____

	SPECIES	CODE	# ADULTS	COMMENTS	TAPE #
Three					
minute					
interval					

Code: 0= nothing heard; 1= individual calls; 2= some overlap of calls; 3= continuous chorus

Notes, Other species heard:_____

Appendix B. Backyard Amphibian and Reptile Surveys Instructions and Data Forms, 1999.

Backyard Amphibian and Reptile Surveys

The Peace/Williston Fish and Wildlife Compensation Program is conducting surveys in the Williston Reservoir watershed to detect the presence of amphibians and reptiles and assess their distribution across this area. **We are inviting local residents with an interest in this project to periodically survey a site (or sites) around their backyards. Any observation records you submit will contribute to a provincial amphibian and reptile information database. By assisting in this effort you are joining a global network of researchers and volunteers who are trying to understand and document the population trends of these animals.**

You can monitor the site of your choice. It can be a backyard pond, the edge of a nearby lake or marsh, or a roadside ditch, for example. Please provide a description of the site location and habitat characteristics on the data form.

There are only 5 amphibian species and 2 reptile species in the Williston Reservoir watershed:

Western Toad
Wood Frog
Columbia Spotted Frog
Striped Chorus Frog*
Long-toed Salamander
Common Garter Snake
Western Garter Snake

*occurs east of the Rocky Mountains

Male frogs and toads call during the spring breeding period (late April and May). Making note of when frogs and toads start calling in your area provides important population and breeding information.

You can familiarize yourself with the calls of frogs and toads in our area by listening to the audio tape provided. Once you are able to distinguish the calls of each species, stand at your site at dusk and **listen for 3 minutes** to hear calling frogs and toads. Write down the species calling, the code of calling (0-3), and the estimated number of individuals calling. Record also the date, time, air temperature, water temperature (if possible), and weather.

Start your surveys as soon as you begin to hear amphibians calling. It is best to fix your count time to a specific time of the evening, preferably around dusk. Don't worry if you miss a few nights! Once the frogs and toads have stopped calling, you can do **periodic visual surveys** of your site(s). Take note (and photos, if possible) of any egg masses, tadpoles, or adults you encounter.

You will need to use a separate data form for each month (and separate data forms for each site, if monitoring more than one). The data sheets ask for only a minimum amount of data; you are encouraged to maintain more detailed field notes if you like. Valuable information may come from your observations!

Send your data forms, notes, and photos etc, to: ***by August 1st, 1999***

Peace/Williston
FISH & WILDLIFE COMPENSATION PROGRAM

1011 Fourth Avenue, 3rd Floor
Prince George, BC V2L 3H9

Ph. 250-565-6588 (Pamela Hengeveld) or 250-565-4191 (Mari Wood)

Backyard Amphibian and Reptile Surveys

DATA FORM

MONTH - Every survey sheet records your observations for one month of one year. Record the month in the space provided at the top right hand corner of the data form. You will start a new data form each month.

DATE - Days of the month are listed down the left side of the data form. You could potentially record an observation for each species in your area on each day of the month.

TIME - Note the time that your survey began.

SPECIES - The species listed on this data form are those that are known to occur in the Williston Reservoir watershed (*Striped Chorus Frogs will likely only be found on the east side of the Rocky Mountains*). However, keep in mind that you may discover a new species to add to the list!

If you are doing a calling survey, write down the calling code (see attached sheet for explanation) and an estimate of the number of individuals you are hearing.

If you are doing a visual survey (i.e., searching your site), write down the number of egg masses you see, an estimate of the number of tadpoles, the number of adults, etc. If you like, use a separate page to write more detailed notes about what you find.

AIR TEMPERATURE - Please circle the scale that you are recording temperatures in: Celsius or Fahrenheit

WATER TEMPERATURE - Please circle the scale that you are recording temperatures in: Celsius or Fahrenheit

WIND - Write down the code which best describes wind strength at the time you are out. See the attached sheet for an explanation of the Beaufort Wind Scale codes.

PRECIPITATION AND CLOUD COVER - Note if it is raining during your survey (or if it did earlier that day). Also, provide an estimate of the percentage of sky that is overcast.

TIME SPENT LISTENING OR SEARCHING - Record the amount of time that you spent conducting your survey. Calling surveys (for frogs and toads) should be only 3 minutes per site. Visual surveys (for amphibian eggs or reptiles) would take longer. It is statistically important to know the relationship between the number of animals that you have seen or heard and the amount of time that you spent looking/listening for them.

SYNOPSIS OF BEAUFORT WIND SCALE

Wind speed is described by a Beaufort force ranging from O to 12, which can be estimated by a verbal characterization of objects moved by the wind. Because of the system's nautical origin, the wind speeds are usually stated in terms of knots, which are here replaced by km/h.

0 CALM, smoke rises vertically, speed less than 1.8 km/h.

1 LIGHT AIR, direction of wind shown by smoke drift but not wind vanes, speed 1.8 - 5.5 km/h.

2 LIGHT BREEZE, wind felt on face / leaves rustle / ordinary vane moved by wind, speed 7.4 - 11 km/h.

3 GENTLE BREEZE, leaves and small twigs in constant motion / wind extends light flag, speed 12 - 19 km/h.

4 MODERATE BREEZE, raises dust and loose paper / small branches are moved, speed 20 - 30 km/h.

5 FRESH BREEZE, small trees in leaf begin to sway / crested wavelets form on inland waters, speed 31 - 39 km/h.

6 STRONG BREEZE, large branches in motion / whistling heard in telephone wires / umbrellas used with difficulty, speed 40 - 50 km/h.

CODE OF CALLING

A four step scale has been developed to simplify the estimation of the number of amphibians you hear. The first step of the scale is code "O". This value is assigned when there are no frogs or toads calling.

The next step is code "1". Assign this number to a species when each frog can be counted separately, and when one frog's call does not start at the same time as another one of the same species. Also fill in the number of individuals you hear calling for that species.

Code "2" is assigned when there are a few males of the same species calling SIMULTANEOUSLY. In this case an exact count is difficult but you can reasonably estimate, the number of individuals present, based on their location relative to you or by the differences in their voices. The calling sounds of the group of males, in this case, is not continuous.

Code "3" is assigned when you encounter a "full chorus". Male amphibians gather in one location to form a "chorus" while they call. When there are so many frogs or toads of one species calling that all the calls sound like they are overlapping and are continuous and it sounds like a blur of sound, then you are hearing a "full chorus" or a Code Three!

In summary:
0 - none heard
1 - individuals of one species can be counted, calls not overlapping
2 - calls of one species are overlapping
3 - Full chorus of one species, calls continuous and overlapping, individuals not distinguishable.

Rankings such as the above have been selected because as the size of the frog choruses increase they become impossible to count.

Backyard Amphibian and Reptile Surveys

Record of Observations for the Month of_____1999

Peace/Williston Fish and Wildlife Compensation Program

DATE	Time of survey (am or pm)	Western Toad	Wood Frog	Columbia Spotted Frog	Striped Chorus Frog	Long-toed Salamander	Garter Snake	Air Temperature (C or F ?)	Water Temperature (C or F ?)	Wind (scale 0-6)	Precipitation & cloud cover	Time spent listening or searching
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
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24												
25												
26												
27												
28												
29												
30												
31												

Appendix C. Weather conditions during the spring 1999 PWFWCP amphibian surveys.

Region	Survey Area	Date	Comments
Peace	Dinosaur, Beryl,	28 Apr - 1 May	Larger lakes in the eastern Peace region (e.g., Cameron and Moberly lakes) were ice-covered on 28 April, but completely open on 1 May. The Beryl Prairie road and the east end of the Johnson Forest Service Road (FSR) were snow-free.
	Gaylard		Carbon Lake (western Johnson FSR) was completely frozen, and patchy snow remained under the trees and in roadside ditches. The weather was part sun and cloud, with temperatures 12-13°C during the day and near 0°C overnight.
	Tacheeda	10 - 11 May	The larger lakes in the Tacheeda area were all or partially ice-covered on 10 and 11 May. Roads which had not been ploughed throughout the winter (e.g., the north end of the Hambone-Chuchinka FSR) were still snow-covered and impassable. The weather was p
	Table	23-25 May	Remnant patches of snow under trees. The weather was initially sunny, with daily temperatures ranging 19.5-26.5°C, and 5°C overnight. By mid-week (25 May) increasing wind and intermittent showers cooled daytime temperatures to 9.5-11.5°C.
	Curve	26-May	The Finlay FSR mainline (west side of the Williston Reservoir) was snow-free, with patchy snow under the trees in upland areas (e.g., 39000 FSR and 47000 FSR), 25-26 May. The weather was cool (9-13°C) and cloudy, with very high winds and 0°C overnight.
Finlay	Aiken, Johanson	27 - 29 May	Most smaller wetland sites were open, others were partially ice-covered, and some extensive areas (e.g., the meadow complex at Nolan Creek) were still completely snow covered. It was snowing lightly on 27 May, with temperatures ranging 3-6°C; the snowfall made surface water slushy in shallow water sites. On 28 and 29 May, the weather was sunny and mild, with temperatures ranging 9-17°C. In the Johanson area it had snowed lightly every day the previous 2 weeks (Reg Locke, Kemess Mine, personal communication).
Peace	Nabesche, West Nabesche	11-Jun	Revelation Lake (West Nabesche River valley, Peace Region) was completely open, but patchy snow remained under the trees. At elevations above 1,200 m there was still a few feet of snow.

Appendix D. PWFWCP Amphibian Reconnaissance Survey Data, 1999.

Date	Site	BEC unit	Survey type[1]	Species[2]	Life Stage[3]	SVL[4] (mm)	Observations
29-Apr	Dinosaur 1	BWBSmwl	AQS	RASY	E		7 distinct indiv. masses, 5-6cm dia ; egg dia. 2mm; masses below water surface on submerged twigs and old Equisetum stalk; 8" from shore; sheltered by willows.
	Beryl 1	BWBSmwl	AQS	RASY	A		didn't see or hear anything during search, but saw min. 12 in water calling loudly between 1715-1800. Also heard 2 RASY calling from site Beryl 2 but couldn't find them.
10-May	Tacheeda 2	SBSwk1	AQS	RALU	E		1 mass, attached to bottom (silt) of sm. blades of grass (2-3 beneath the mass), otherwise substrate is bare around the eggs; jelly ~5mm around indiv. egg; mass dia. ~ 12.0cm
	Tacheeda 7	SBSwk1	AQS	BUBO	J	21	swimming in water at shore
	Tacheeda 7	SBSwk1	AQS	*Tham*	A		on shore of pool where RALU found; red stripe; 30-60 cm length
	Tacheeda 7	SBSwk1	AQS	RALU	A		swam under bulrushes & silt when they noticed us; saw 3-4 at water surface at a time
	Tacheeda 7	SBSwk1	AQS	RALU	J	44	swam under bulrushes & silt when they noticed us; saw 3-4 at water surface at a time
	Tacheeda 7	SBSwk1	AQS	RALU	J	35	swam under bulrushes & silt when they noticed us; saw 3-4 at water surface at a time
	Tacheeda 7	SBSwk1	AQS	RALU	J	27	swam under bulrushes & silt when they noticed us; saw 3-4 at water surface at a time
	Tacheeda 7	SBSwk1	AQS	RALU	J 2		2 RALU at S end of the site in very thick red algae
24-May	Table 1	SBSvk	AQS	*Tham.*	A		found in water; yellow stripe; very thin compared to record 5; 20-25 cm length
	Table 2	SBSvk	AQS	BUBO	J		swimming in sm. (.25x1 m) isolated pool, .1-.2m deep with some grass in it along edge
	Table 2	SBSvk	AQS	BUBO	J		swimming in sm. (.25x1 m) isolated pool, .1-.2m deep with some grass in it along edge
	Table 2	SBSvk	AQS	BUBO	J		brown; in grass
	Table 4	SBSvk	AQS	RALU	A	65	RALU jumped into oily puddle
	Table d	SBSvk	BCS	BUBO	A	~50	seen (not heard calling) in water channel along the road
25-May	Table 5	SBSvk	AQS	*Tham.*	A		very thick, bit of a bulge when he curled up; was lying in the sun 0.5m from road, 20cm from stream; when provoked, snake curled up, smearing white pungent slime over itself; ~15 cm length
	Table 6	SBSvk	AQS	RALU	E		1 mass, not attached to anything; dia. 130x130mm, egg dia. with jelly 5-7.5mm, larval lgth ave. 3mm (1mm wide)-some a little bigger; ~160 eggs; soft bottom, old matted grasses (algae covered); eggs floating at surface; water depth 22cm
	Table 6	SBSvk	AQS	BUBO	J	21	
26-May	Curve 3	SBSwk2	AQS	RASY	E		all masses at water surface, all attached to veg.; 3 masses: mass dia. 45x45mm, 80x70, 70x50, egg dia. 4-5; another 3 masses 2 ft away: mass dia. 70x60, 80x60, 75x55, egg dia. 4-5mm; eggs hatching; hatchling lgth 8-9mm, body and tail are equal length
28-May	Aiken 2	ESSFmv4	AQS	RALU	E		SW end: 12-13 masses, all attached except 2, 4-5 masses are clumped together, eggs are very clear NW end: 9-10 masses together (attached to grass), 8 separate but w/in 2 feet, many have algal look to them, 1 mass very clear, 5 masses not attached; masses 7-10cm dia., egg~1cm ind. jelly
	Aiken 2	ESSFmv4	AQS	RALU	A		frog swimming (submerged ~6") from shore into wide hole in algal substrate

...continued

Appendix D. *Continued.*

Date	Site	BEC unit	Survey type[1]	Species[2]	Life Stage[3]	SVL[4] (mm)	Observations
10-Jun	Nabesche 4	BWBSwk2	AQS	BUBO	J	22	crawling out of small pool thick with algae
	WestNab.1	ESSFwk2	AQS	BUBO	A	70	on old matted grass near lake shore, where meltwater flows in from upland
	WestNab.1	ESSFwk2	AQS	BUBO	A	85	on old matted grass near lake shore
	WestNab.2	ESSFwk2	AQS	BUBO	A	75	at base of krummholz ~7m from water
11-Jun	Canty 1	ESSFwk2	AQS	BUBO	A		dead at bottom of beaver channel
	Canty 1	ESSFwk2	AQS	BUBO	A 2		freshly killed (by mink or otter?); they were likely in amplexus/laying eggs; in shallow water (.2-.25m) grassy area
	Canty 1	ESSFwk2	AQS	BUBO	A 2	91 & 87	pair in amplexus; male calling occasionally; in beaver channel (depth .3m, width .15m)
	Canty 1	ESSFwk2	AQS	BUBO	A	62	hanging submerged 5-10cm below surface in beaver channel
	Canty 1	ESSFwk2	AQS	BUBO	A 2		2 females freshly killed; full of eggs; within 2 feet of other dead pair in shallow *(.2-25)* grassy area
	Canty 1	ESSFwk2	AQS	BUBO	A 2		in amplexus; laying eggs in shallow (.2-.25) grassy area
	Canty 1	ESSFwk2	AQS	BUBO	A 2		female with eggs, skin torn, eggs bulging out, barely alive (FC pithed it) Carcass beside it freshly killed; completely torn apart; ~5m north of other killed pair & pair in amplexus; in shallow (.2- 25m) grassy area
	Canty 1	ESSFwk2	AQS	BUBO	A		in water near treed shoreline; calling loudly across lake (~20m distance)
	Canty 1	ESSFwk2	AQS	BUBO	A	85-90	sitting in sun on grass at base of tree 2ft from lake edge; didn't move; released water when I picked it up and was active in my hand; did not call even when disturbed
	Canty 1	ESSFwk2	AQS	BUBO	A 3	91 & 84	under 1.5m long. 3cm dia., log in water; 2 in amplexus (male heard calling even underwater), third one also calling
	Canty 1	ESSFwk2	AQS	BUBO	A		on lake bottom at shoreline
	Tacheeda 2	SBSwk1	AQS	RALU	A	56	
	Tacheeda 2	SBSwk1	AQS	RALU	A	61	
	Tacheeda 2	SBSwk1	AQS	RALU	L	21/6	sparsely distributed throughout the site
	Tacheeda 2	SBSwk1	AQS	RALU	L	18/8	sparsely distributed throughout the site
	Tacheeda 2	SBSwk1	AQS	AMMA	L	15/?	easily observed (abundant) throughout the site
7-Jul	Squawfish 1	ESSFmv3	AQS	BUBO	A		jumped into shallow grassy water within 1-2m of shoreline
	Squawfish 1	ESSFmv3	AQS	RALU	L	25/10	pale gold/bronze belly, translucent fin, trunk same colour all the way through, high tail fin arch; swimming offshore a bit, dove into substrate
	Squawfish 1	ESSFmv3	AQS	RALU	L	24/10	pale gold/bronze belly, translucent fin, trunk same colour all the way through, high tail fin arch
	Squawfish 1	ESSFmv3	AQS	RALU	L	23/11	pale gold/bronze belly, translucent fin, trunk same colour all the way through, high tail fin arch
	Squawfish 1	ESSFmv3	AQS	RALU	L	25/9	pale gold/bronze belly, translucent fin, trunk same colour all the way through, high tail fin arch
	Squawfish 1	ESSFmv3	AQS	RALU	L	19/8	pale gold/bronze belly, translucent fin, trunk same colour all the way through, high tail fin arch
	Squawfish 1	ESSFmv3	AQS	RALU	L	26/13	pale gold/bronze belly, translucent fin, trunk same colour all the way through, high tail fin arch
	Squawfish 1	ESSFmv3	AQS	RALU	L	21/9	pale gold/bronze belly, translucent fin, trunk same colour all the way through, high tail fin arch
	Moosmoos 1	ESSFmv2	AQS	RASY	J	25	swimming in shallow (.25m) water among sedges/grasses
	Moosmoos 1	ESSFmv2	AQS	RASY	J	23	on sedge mat; jumped into water
	Moosmoos 1	ESSFmv2	AQS	RALU	A	68	sitting at base of dry lichen slope, within 1 m of shoreline

...continued

Appendix D. *Continued.*

Date	Site	BEC unit	type[1]	Species[2]	Stage[3]	(mm)	Observations
	Moosmoos 1	ESSFmv2	AQS	RALU	A	67	at shoreline, same area as other adult RALU
	Moosmoos 1	ESSFmv2	AQS	RALU	L	33/13	swimming and suspended in 1-1.5m deep backchannel
	Moosmoos 1	ESSFmv2	AQS	RALU	L	33/15	swimming and suspended in 1-1.5m deep backchannel
	Moosmoos 1	ESSFmv2	AQS	RALU	L	27/16	swimming and suspended in 1-1.5m deep backchannel
	Moosmoos 1	ESSFmv2	AQS	RALU	L	29/18	swimming and suspended in 1-1.5m deep backchannel
	Moosmoos 1	ESSFmv2	AQS	RALU	L	26/14	swimming and suspended in 1-1.5m deep backchannel; tail slightly 'eaten'
	Moosmoos 1	ESSFmv2	AQS	RALU	L	27/15	swimming and suspended in 1-1.5m deep backchannel
	Scovil 2	ESSFmv3	AQS	BUBO	A	56	
	Scovil 2	ESSFmv3	AQS	BUBO	A	74	calling; audio recording made
21-Jun	Tacheeda 2	SBS wk1	AQS	AMMA	L 3	~25/?	
19-Aug	Tacheeda 2	SBSwk1	AQS	AMMA	L 4	51/38	
29-Apr	Beryl a	BWBS mw1	BCS	RASY	C		breeding call code 1
	Beryl c	BWBS mw1	BCS	RASY	C		breeding call code 2; also calling in choruses at noon on 30 Apr
		BWBS mw1	BCS	PSTR	C		breeding call code 3; also calling in choruses at noon on 30 Apr
	Beryl d	BWBS mw1	BCS	RASY	C		breeding call code 2
		BWBS mw1	BCS	PSTR	C		breeding call code 3
	Beryl e	BWBS mw1	BCS	RASY	C		breeding call code 3
		BWBS mw1	BCS	PSTR	C		breeding call code 3
	Beryl f	BWBS mw1	BCS	RASY	C		breeding call code 2
	Beryl g	BWBS mw1	BCS	RASY	C		breeding call code 1
		BWBS mw1	BCS	PSTR	C		breeding call code 1
	Beryl h	BWBS mw1	BCS	RASY	C		breeding call code 2
30-Apr	Gaylard f	SBSwk2	BCS	RASY	C		breeding call code 3
		SBSwk2	BCS	BUBO	C		breeding call code 1
		SBSwk2	BCS	RALU	C		breeding call code 1
	Dinosaur b	BWBSmwl	BCS	RASY	C		breeding call code 1
28-May	Aiken h	ESSFmv4	BCS	RASY	C		breeding call code 1

[1] Survey type: aquatic survey (AQS), breeding call survey (BCS), incidental observation (INC).

[2] Species: western toad *(Bufo boreas,* BUBO), Columbia spotted frog (Rana *luteiventris,* RALU), wood frog (*Rana sylvatica,* RASY), long-toed salamander *(Ambystoma macrodactylum,* AMMA), garter snake *(Thamnophis spp., Tham .).*

[3] Life stage: eggs (E), larvae (L), juvenile (J), adult (A). Numeral suffix indicates number of individuals observed.

[4] SVL: snout-to-vent length measurements for juvenile and adult frogs and toads. Larval measurements are expressed as total length / head (body) length.

Appendix E. Backyard Amphibian and Reptile Survey Site Descriptions and Observations.

Moose Valley airstrip

Observer: Ron Steffey

Location: 9.643200.6290000 (approx.)

Two ponds near the north end of the Moose Valley airstrip along the west edge of the airstrip were repeatedly surveyed. They were probably formed by excavation equipment for the lengthening of the airstrip in 1987. There is about 20 m between the ponds, but when the water is high (a short period of time) the ponds are connected by small streams. The south pond is approximately 70 x 20 m in June, and nearly 1.5 m deep at the deepest point. It is surrounded by gravel and has a gravel bottom with very little vegetation (i.e., a couple of willow brush clumps and a couple clumps of Carex spp. grass). The north pond is approximately 110 m by 25 m in June. It has a gravel bottom and gravel around most of the perimeter. The southwest side has some soil and vegetation (willow brush and Carex spp. grass). It is less than 1 m at depth. During high water there is an overflow stream flowing out the northeast corner, eastward along the north end of the airstrip to Moose Valley Creek.

Amphibian observations made by Ron Steffey, Moose Valley airstrip, June-July 1999.

Date	Pond	Observations
4 Jun	North	Adult toad found in the S end. No eggs observed.
	South	Mass of eggs the size of a large orange found in the NE end of the pond. The mass was attached to a blade of Carex grass, near the bottom of the pond in about 25 cm of water. The mass was easily dislodged.
11 Jun	North	Scanned the N end of the pond for a minute or so but saw nothing.
	South	An adult frog or toad was within 1 m of the egg mass. The egg mass had spread out and was somewhat frothy and floating. What appeared as black dots in the egg centers on 4 Jun had now elongated slightly.
14 Jun	North	Scanned the pond quickly but saw nothing.
	South	The egg mass was frothy and flattened, with tiny hatchlings in the mass. There was again an adult frog or toad near the mass.
30 Jun	North	Tadpoles (all black in colour) were observed at varying densities throughout the pond. Over 10,000 tadpoles were estimated to be within 1 m of shore. The ponds were not connected to each other, and no longer connected to the creek. The water level was at least 1 ft. lower than on 14 Jun.
	South	Only a few tadpoles (all grey/green in colour) were observed, some twice the size of others.
16 Jul	North	Water levels were very low. The pond had extensive dry areas and tadpoles were becoming isolated in small pools.
	South	All tadpoles were grey/green, with more plump bodies than the black tadpoles in the north pond.

Appendix E. *continued.*

Germansen Landing

Observer: Emily Muller, Nerida Muller

Location: 10.6183508.393296 (approx.)

The pond is 20 x 15 ft. normally, but overflows during the flood season. Open, grassy, human-influenced surroundings, with a Wusteria hedge on one side. The pond has water year-round; water depth during the summer is 4-5 ft. deep.

Amphibian observations made by Emily and Nerida Muller, Germansen Landing, April - July 1999.

	Time	Cloud			Temp (C)				
Date	(hrs)	Cover (%)	Precip.	Wind	air	water	Species[1]	Life stage	Comments
30-Apr	1530	100	No	Calm	-1		Frog	5-8 adults	First frogs (5-8) of the year appeared around noon. Found the holes they had dug out of. A few hours later a mating pair was found laying eggs.
1-May	2200	50	Earlier today	Light-mod.	11	17	BUBO	8-10 adults	
							RALU	15 adults	Heard BUBO and RALU breeding calls (code 1-2). Found 3 very thin, sleepy BUBO staggering from hibernation to the pond.
11-May	1535	100	No	Gentle	12	14	BUBO	2 adults	
							RALU	6-7 egg clumps	
12-May	1800	100	Yes	Light	12.5	17.5	BUBO	20 adults	
							RASY	~3 adults and 1 egg clump	
							RALU	8 egg clumps	
13-May	1215	100	No	mod.	10	15	BUBO	20 adults (2 mating)	One BUBO pair mating.
							RASY	6 adults and 4 egg clumps	
14-May	1850	33	Earlier today	gentle	12	18	BUBO	~ 20 adults	
							RASY	1 adult	
16-May	1440	20	Yes	light	5		BUBO	20 adults	
							RASY	10 adults	
							RALU	1-2 adults	
17-May	1540	60	Yes	light	16	16	BUBO	1 adult	
							RASY	6 adults	
							RALU	8 adults	

continued

Appendix E. *continued.*

Germansen Landing continued.

Date	Time (hrs)	Cloud Cover (%)	Precip.	Wind	Temp (C) air	Temp (C) water	Species[1]	Life stage	Comments
19-May	2005	90	Earlier	light	11	16	BUBO	5 adults and ~ 4 egg strings	2 female BUBO laying eggs. No tadpoles.
							RASY	6 egg clumps	
							RALU	8 egg clumps	
23-May	2015	>50	No	light	16	15	RASY	2-3 adults	
25-May	1815	33	Earlier	mod.	9		RASY	~4adults	Heard ~4 RASY calling (did not see them).
26-May	1732			light	~10		RALU	~ 6 egg clumps	
31-May	1510	50	No	mod.	12	14	BUBO	1 adult and 10 dead	The 10 dead BUBO included several mating couples and females with eggs killed by a common raven.
							RASY	~3 adults	
							RALU	1 adult	
2-Jun	1700	75	No	gentle	18	16	BUBO	2 adults	BUBO mating pair
							RASY	1-2 adults	
							RALU	~2 adults	
24-Jun	1620	90	Earlier	light	16		BUBO	1 juvenile	
							RALU	7 adults and 6 juv.	
							undl.	tadpoles (100's)	
30-Jun	1629	100	Yes	calm	~15		RALU	3 adults	
2-Jul	1820	40	No	light	17		BUBO	1 juvenile	
							RASY	4 juveniles	
							RALU	10 adults and 10 juveniles	
10-Jul	2005	90	Earlier	light	17		BUBO	1 adult and 1 juvenile	
							RASY	~2	
							RALU	~40 (adults and juv.)	
12-Jul	1935	70	No	strong	18		RALU	8 adults	
13-Jul	1930	80	Yes	light	16	18	BUBO	1 juvenile	
							RASY	3 (2 juveniles)	
							RALU	~40 (adults and juveniles)	
							undl.	~20 tadpoles	
14-Jul	1450	10	No		16		BUBO	1 juvenile	Couldn't find any toads. Some wind.
							RALU	38	

[1] Species: western toad *(Bufo boreas*, BUBO); wood frog (Rana sylvatica, RASY); Columbia spotted frog (Rana luteiventris, RALU); unclassified species (uncl.).

Appendix F. Location coordinates for all amphibian sites identified in the Williston and Dinosaur Reservoir watersheds by the PWFWCP and Slocan Group. Mackenzie Operations, 1995-1999. Site names in bold indicate that the site was identified as an amphibian breeding location.

BGZ unit	Site Name[1]	Site Location	UTM Coordinates[2] Z	Easting	Northing	Elev (m)	Data Source
PARSNIP REGION							
SBS mk1	**Squaw Lake 1**	Squaw Lake	10	519400	6037130	710	This study
	Squaw Lake 2	Squaw Lake	10	521000	6036000	710	This study
	Bear Lake	Bear Lake	10	522000	6031300	710	This study
	A2	Sabai FSR at 18.9 km	10	489000	6095000	860	Hengeveld 1999
	A3	Sabai FSR at 18.7 km	10	489000	6095000	860	Hengeveld 1999
	A6	Sabai FSR at 12.3 km	10	492844	6097577	710	Hengeveld 1999
	A11	Sabai FSR at 11.2 km	10	493500	6098000	710	Hengeveld 1999
	A14	Finlay FSR 2.0 km W of Tudyah Rec. Site	10	498500	6106000	700	Hengeveld 1999
	Philip 1	Philip North Rd at 41 km	10	461858	6128587	880	Slocan Group
	Philip 2	Philip North Rd at 40 km	10	461328	6106267	870	Slocan Group
	Philip 3	Finlay FSR at 25 km	10	487007	6117748	730	Slocan Group
	Philip 4	Philip FSR at 16 km, cutblock 187	10	478530	6101057	1040	Slocan Group
	Philip 6	Finlay FSR at 3 km	10	498583	6108610	700	Slocan Group
	Blackwater 6	Nation FSR at 35 km, cutblock 4778	10	447530	6138567	1060	Slocan Group
	Blackwater 8	18000 Rd (S of Genesis Lake), in cutblock 213-482		461345	6128824	890	Slocan Group
	Blackwater 10	Genesis Lake	10	461265	6133571	1010	Slocan Group
	Wolverine 5000 FSR	Wolverine 5000 FSR at 6.5 km	10	446000	6143000	1110	Hengeveld 1999
	Manson 12000 FSR	Manson 12000 FSR at 2.9 km	10	436560	6167000	1020	Hengeveld 1999
SBS mk2	**Mackenzie 2**	Williston Reservoir shoreline	10	489349	6136135	670	Slocan Group
	Mackenzie 3 / G2	Mugana Marsh	10	488877	6139387	680	Slocan Group, Hengeveld 1999, this study
	Blackwater 3 / B3	14000 (Blackwater) Rd at 3.4 km	10	455850	6153965	740	Slocan Group, Hengeveld 1999
	Blackwater 5	Finlay FSR at 84 km	10	453126	6158321	760	Slocan Group
	B4	14000 (Blackwater) Rd at 0.8 km	10	455095	6156171	740	Hengeveld 1999
	B6	Finlay FSR at 73 km	10	465597	6153197	750	Hengeveld 1999
	C1	9000 Rd at 8.7 km	10	460500	6164150	750	Hengeveld 1999
	Blackwater 1000 FSR	1000 FSR at 1.0 km (just N of Nation Arm)	10	472000	6153500	780	Hengeveld 1999
	Bug Lk Rd	Bug Lk Rd at 1.3 km (just N of Nation Arm)	10	466500	6158000	880	Hengeveld 1999
	Mouth of Manson R	Floodplain at mouth of Manson R	10	446000	6177000	670	This study
	Robert's Pond	On road to Robert's Pond (SW of Manson Arm)	10	446000	6172000	690	This study
	Strandberg	Strandberg tributary and roadside area	10	428000	6147500	730	Hengeveld 1999
SBS wk1	**Tacheeda 2**	2000 FSR at 2039.1 km	10	520301	6052606	750	This study
	Tacheeda 5	1000 FSR at 9.5km S of Parsnip R bridge	10	539594	6063868	740	This study
	Tacheeda 7	1000 FSR at 13.4km S of Parsnip R bridge	10	543408	6062911	750	This study

continued

Appendix F. *continued.*

BGZ unit	Site Name[1]	Site Location	UTM Coordinates[2] Z	Easting	Northing	Elev (m)	Data Source
SBS wk2	Mackenzie 1	John Dahl Park	10	495259	6131456	760	Slocan Group
	E5	3.3 km on road off 113 km on Finlay FSR mainline	10	435216	6178492	820	Hengeveld 1999
	E7	2.2 km on road off 113 km on Finlay FSR	10	436251	6178159	820	Hengeveld 1999
	F2	Finlay FSR at 114.3 km	10	437548	6178072	810	Hengeveld 1999
	Curve 3	39000 FSR at 3.4 km (1.2 km to fork, 2.2 km on left fork)	10	434954	6178167	860	This study
SBS vk	Table 3	1000 FSR at 26.6 km S of Parsnip R bridge	10	554391	6068193	780	This study
	Table 4	1000 FSR at 30 km (29.5 km to fork, 0.5 km on right fork) S of Parsnip R bridge	10	557244	6068497	770	This study
	Table 6	1000 FSR at rhwy crossing 32 km (29.5 km to fork, 2.5 km on right fork, east side) S of Parsnip R bridge	10	559187	6068117	780	This study
	Table d	1000 FSR at 30.5 km (29.5 km to fork, 1.0 km on right fork) S of Parsnip R bridge	10	557831	6068456	770	This study
ESSF mv2	**Moosmoos 1**	Moosmoos Crk (helicopter access)	10	398720	6138212	1010	This study
ESSF mv3	**Squawfish 1**	Squawfish Lk (helicopter access)	10	403668	6145616	1170	This study
	Scovil 2	Mt. Scovil area (helicopter access)	10	465784	6137052	1490	This study
	Blackwater 11	near Sylvester Crk, in cutblock 270-4106	10	411770	6126367	1150	Slocan Group
ESSF wk2	**Canty 1**	Canty Lk (helicopter access)	10	455970	6201323	1330	This study
PEACE REGION							
SBS wk2	Clearwater 1	Northwest of cutblock 32-1	10	492532	6185189	790	Slocan Group
	Clearwater 4	Callazon FSR at 16 km, adj. to Clearwater Lake	10	507926	6162838	1030	Slocan Group
	J1	Johnson FSR at 56.8 km	10	532184	6206277	910	Hengeveld 1999
	J3 / Gaylard f	Johnson FSR at 54.8 km	10	533413	6207001	910	Hengeveld 1999, this study
	Mt Brewster	confluence of unnamed creeks SW of Mt Brewster	10	488500	6222000	800	Hengeveld 1999
BWBS mw1	**K4 / Dinosaur 1**	Johnson FSR at 12.4 km	10	555041	6196289	710	Hengeveld 1999, this study
	K6	Johnson FSR at 6.8 km	10	559714	6197109	800	Hengeveld 1999
	Dinosaur b	Johnson FSR at 46.2 km	10	539492	6207294	790	This study
	Beryl 1	Beryl Prairie Rd at 27.0 km	10	556822	6233349	830	This study
	Beryl 2	Beryl Prairie Rd at 27.1 km	10	556822	6233349	830	This study
	Beryl 3 / Beryl c	Beryl Prairie Rd at 4.7 km	10	559637	6214457	720	This study
	Beryl a	Beryl Prairie Rd at 2.5 km	10	559673	6212296	715	This study
	Beryl d	Beryl Prairie Rd at 6.0 km	10	559638	6215754	730	This study
	Beryl e	Beryl Prairie Rd at 6.7 km	10	559591	6216645	730	This study
	Beryl f	Beryl Prairie Rd at 14.1 km	10	557936	6222303	730	This study
	Beryl g	Beryl Prairie Rd at 17.4 km	10	556293	6224298	750	This study
	Beryl h	Beryl Prairie Rd at 22.4 km	10	556457	6229154	770	This study
BWBS wk1	Ruddy Crk	Ruddy Crk, Butler Ridge	10	546500	6229000	1100	Hengeveld 1999
BWBS wk2	Nabesche 4	Nabesche R (helicopter access)	10	480378	6242770	960	This study

continued

Appendix F. *continued.*

BGZ unit	Site Name[1]	Site Location	UTM Coordinates Z	Easting	Northing	Elev (m)	Data Source
ESSF wk2	WestNab 1	N of West Nabesche R (helicopter access)	10	479173	6234502	1270	This study
	WestNab 2	N of West Nabesche R (helicopter access)	10	479173	6234502	1270	This study
FINLAY REGION							
SBS mk2	Ospika 1	Ospika FSR at 19 km	10	439583	6249827	690	Slocan Group
	Ospika 2	Collins Bay	10	414844	6255694	690	Slocan Group
	Ospika 3	S of Lafferty Crk, in cutblock 577-324	10	420974	6244442	760	Slocan Group
BWBS dk1	D2 / Germansen Landing	25.0 km N of Wolverine Lks Rec Site	10	393296	6183509	760	Hengeveld 1999, this study
	D3	24.5 km N of Wolverine Lks Rec Site	10	392944	6183443	770	Hengeveld 1999
	D4	19.2 km N of Wolverine Lks Rec Site	10	394916	6179151	890	Hengeveld 1999
	D9	8.4 km N of Wolverine Lks Rec Site	10	403030	6175107	980	Hengeveld 1999
	D11	2.1 km N of Wolverine Lks Rec Site	10	407833	6172913	900	Hengeveld 1999
	Osilinka R	upper Osilinka River	10	*424800*	*6220600*	1500	This study
	Buffalohead 1	off Pelly FSR, cutblock 653-7	10	376315	6304165	770	Slocan Group
	Buffalohead 2	Del Lake, off Del FSR	10	364993	6337844	770	Slocan Group
	Buffalohead 4	off Finlay FSR, N of Deserter's Crk	10	378535	6316875	810	Slocan Group
	Buffalohead 5	Finlay FSR at 34 km, N of Akie R	10	372864	6325371	710	Slocan Group
	Buffalohead 6	N of Chowika Bay, S of cutblock 559-50	10	393418	6291505	690	Slocan Group
	Buffalohead 8	off Finlay FSR, S of Blanchard Crk, S of cutblock 658-508	10	366502	6333029	750	Slocan Group
	Buffalohead 12	S of Pelly FSR, S of cutblock 8033	10	375366	6301347	800	Slocan Group
	Buffalohead 13	off Pelly FSR, N of cutblock 653-17	10	376132	6306584	730	Slocan Group
	Buffalohead 15	off Finlay FSR, S of Pesika Crk	10	377974	6316245	710	Slocan Group
ESSF mc	Two Lake Crk	Two Lake Crk, 8-10 km from confluence with Sustut R	9	*636000*	*6272000*	1030	This study
ESSF mv3	Tenakihi FSR	Tenakihi FSR at 49 km	10	*350000*	*6233000*	1250	This study
ESSF mv4	Aiken h	Thutade FSR at 58.4km	10	328876	6260293	1130	This study
	Aiken 2	Thutade FSR at 378 km	10	317656	6271584	1260	This study
	Aiken 1 / Thutade 380	Thutade FSR at 380 km	9	683828	6272856	1340	This study
SWB mk	Thutade 412	Thutade FSR at 412 km	9	*662500*	*6277500*	1330	This study
	Moose Valley	old airstrip at Moosevale Crk (Thutade FSR at ~ 435 km)	9	*643200*	*6290000*	1260	This study
	Thutade 448	Thutade FSR at 448.25 km	9	*638500*	*6300000*	1230	This study

[1] Name of survey site as assigned by the observer. Some sites have multiple names (e.g., Mackenzie 3 / G2 / Mugaha Marsh).

[2] UTM coordinates were primarily obtained using a GPS unit (NAD83); italicized coordinates were approximated from topographic maps.

Appendix G. Dates of amphibian breeding call detection and amphibian egg presence at various sites in the Williston and Dinosaur Reservoir watersheds, 1995-1999.

Amphibian breeding calls detected.

Species	Year	Month	Day	Call code[1]	Survey Site	Elev (m)	BGZ subunit	Region	Source
Western toad	1998	May	11	2	A2	860	SBS mk1	Parsnip	Hengeveld 99
			11	1	A3	860	SBS mk1	Parsnip	Hengeveld 99
			12	2	B3	740	SBS mk2	Parsnip	Hengeveld 99
			13	1	B6	750	SBS mk2	Parsnip	Hengeveld 99
			13	1	Germansen Ldg / D2	760	BWBS dk1	Finlay	Hengeveld 99
			14	1	E5	820	SBS wk2	Parsnip	Hengeveld 99
	1999	May	1	1	Germansen Ldg / D2	760	BWBS dk1	Finlay	This study
		Jun	11	1	Canty 1	1330	ESSF wk2	Parsnip	This study
Wood frog	1998	May	12	1	B3	740	SBS mk2	Parsnip	Hengeveld 99
			13	2	Germansen Ldg / D2	760	BWBS dk1	Finlay	Hengeveld 99
			13	2	D3	770	BWBS dk1	Finlay	Hengeveld 99
			13	1	D4	890	BWBS dk1	Finlay	Hengeveld 99
			13	1	D9	980	BWBS dk1	Finlay	Hengeveld 99
			14	1	D11	900	BWBS dk1	Finlay	Hengeveld 99
			14	1	E7	820	SBS wk2	Parsnip	Hengeveld 99
			14	1	F2	810	SBS wk2	Parsnip	Hengeveld 99
	1999	Apr	28	2	Mackenzie 3 / Mugaha	680	SBS mk2	Parsnip	This study
			29	3	Beryl 1	830	BWBS mw1	Peace	This study
			29	1	Beryl 2	830	BWBS mw1	Peace	This study
			29	3	Beryl 3 / Beryl c	720	BWBS mw1	Peace	This study
			29	1	Beryl a	715	BWBS mw1	Peace	This study
			29	2	Beryl d	730	BWBS mw1	Peace	This study
			29	3	Beryl e	730	BWBS mw1	Peace	This study
			29	2	Beryl f	730	BWBS mw1	Peace	This study
			29	1	Beryl g	750	BWBS mw1	Peace	This study
			29	2	Beryl h	770	BWBS mw1	Peace	This study
			30	1	Dinosaur b	790	BWBS mw1	Peace	This study
		May	11	1	Tacheeda 5	740	SBS wk1	Parsnip	This study
			25	1	Germansen Ldg / D2	760	BWBS dk1	Finlay	This study
			28	1	Aiken n	1130	ESSF mv4	Finlay	This study
Columbia spotted frog	1998	May	11	1	A6	710	SBS mk1	Parsnip	Hengeveld 99
			12	1	A14	700	SBS mk1	Parsnip	Hengeveld 99
			13	1	B6	750	SBS mk2	Parsnip	Hengeveld 99
			13	1	Germansen Ldg / D2	760	BWBS dk1	Finlay	Hengeveld 99
			13	1	D3	770	BWBS dk1	Finlay	Hengeveld 99
	1999	May	1	1	Germansen Ldg / D2	760	BWBS dk1	Finlay	This study
Striped chorus frog	1999	Apr	29	3	Beryl 3 / Beryl c	720	BWBS mw1	Peace	This study
			29	3	Beryl d	730	BWBS mw1	Peace	This study
			29	3	Beryl e	730	BWBS mw1	Peace	This study
			29	1	Beryl g	750	BWBS mw1	Peace	This study

Call codes refer to the frequency of calls: 1 (no overlap in calls from a single species), 2 (calls of one species are overlapping but distinct), or 3 (full chorus of one species; calls continuous and overlapping, individuals not distinguishable).

Appendix G. *Continued.*

Amphibian egg presence.

Species	Year	Month	Day	Survey Site	Elev (m)	BGZ subunit	Region	Source
Western toad	1995	May	18	Buffalohead 1	770	BWBS dk1	Finlay	Slocan Group
			20	Mackenzie 3 / Mugaha	680	SBS mk2	Parsnip	Slocan Group
	1996	May	26	Mackenzie 3 / Mugaha	680	SBS mk2	Parsnip	Slocan Group
			28	Blackwater 3	740	SBS mk2	Parsnip	Slocan Group
	1997	May	10	Blackwater 11	1150	ESSF mv3	Parsnip	Slocan Group
			14	Blackwater 5	760	SBS mk2	Parsnip	Slocan Group
	1998	May	13	Germansen Ldg / D2	760	BWBS dk1	Finlay	Hengeveld 99
	1999	May	19	Germansen Ldg / D2	790	BWBS dk1	Finlay	This study
		Jun	11	Canty 1	1330	ESSF wk2	Parsnip	This study
Wood frog	1995	May	18	Buffalohead 1	770	BWBS dk1	Finlay	Slocan Group
	1996	Jun	16	Philip 4	1040	SBS mk1	Parsnip	Slocan Group
	1997	May	21	Buffalohead 4	810	BWBS dk1	Finlay	Slocan Group
			22	Buffalohead 1	770	BWBS dk1	Finlay	Slocan Group
	1999	Apr	29	Dinosaur 1	710	BWBS mw1	Peace	This study
		May	12 - 19	Germansen Ldg / D2	760	BWBS dk1	Finlay	This study
			26	Curve 3	860	SBS wk2	Parsnip	This study
Columbia spotted frog	1995	May	15	Mackenzie 2	670	SBS mk2	Parsnip	Slocan Group
	1996	May	22	Mackenzie 2	670	SBS mk2	Parsnip	Slocan Group
			25	Mackenzie 3 / Mugaha	680	SBS mk2	Parsnip	Slocan Group
	1997	May	10	Blackwater 11	1150	ESSF mv3	Parsnip	Slocan Group
			21	Buffalohead 4	810	BWBS dk1	Finlay	Slocan Group
			22	Buffalohead 1	770	BWBS dk1	Finlay	Slocan Group
			22	Buffalohead 12	800	BWBS dk1	Finlay	Slocan Group
		Jun	10	Blackwater 10	1010	SBS mk1	Parsnip	Slocan Group
	1998	May	13	Germansen Ldg / D2	760	BWBS dk1	Finlay	Hengeveld 99
			13	D4	890	BWBS dk1	Finlay	Hengeveld 99
	1999	May	10 - 23	Tacheeda 2	750	SBS wk1	Parsnip	This study
			11 - 26	Germansen Ldg / D2	760	BWBS dk1	Finlay	This study
			25	Table 6	780	SBS vk	Parsnip	This study
			28	Aiken 2	1260	ESSF mv4	Finlay	This study
		Jun	4	Moose Valley	1260	SWB mk	Finlay	This study
Unclassified frog	1999	Jun-Jul	18 28	Thutade 412	1330	SWB mk	Finlay	This study
		Jun	29	Thutade 448	1230	SWB mk	Finlay	This study
Long toed salamander	1997	Jun	10	Blackwater 10	1010	SBS mk1	Parsnip	Slocan Group
	1998	May	11	A11	710	SBS mk1	Parsnip	Hengeveld 1999
			12	B4	740	SBS mk2	Parsnip	Hengeveld 1999
			12	C1	750	SBS mk2	Parsnip	Hengeveld 1999

Eggs were observed at the site at unspecified dates between June 18 and July 28.